DOCUMENT RESUME

ED 022 673 24 SE 004 631

By-Ryan, James J.

EFFECTS OF MODERN AND CONVENTIONAL MATHEMATICS CURRICULA ON PUPIL ATTITUDES, INTERESTS, AND PERCEPTION OF PROFICIENCY.

Minnesota State Dept. of Education, St. Paul. Minnesota National Laboratory.

Spons Agency-Office of Education (DHEW), Washington, D.C. Bureau of Research.

Bureau No-BR-5-1028

Pub Date Jan 68

Contract-OEC-5-10-051

Note-169p.

EDRS Price MF-$0.75 HC-$6.84

Descriptors-*ACHIEVEMENT, COMPARATIVE ANALYSIS, *CURRICULUM, *CURRICULUM DEVELOPMENT, GRADE 9, *MATHEMATICS, *SECONDARY SCHOOL MATHEMATICS, STUDENT ATTITUDES, STUDENT INTERESTS

Identifiers-Ball State Mathematics Program, School Mathematics Study Group

This project was initiated (1) to determine the effects of three experimental "modern" programs in secondary mathematics--the Ball State, University of Illinois Committee on School Mathematics (UICSM), and the School Mathematics Study Group programs--on the attitudes and interests pupils develop toward mathematics and (2) to examine factors and conditions related to these effects. The project consisted of a number of separate studies which involved 126 pairs of secondary mathematics ninth grade classes in school districts from a five-state area--Minnesota, Wisconsin, Iowa, and North and South Dakota. The results of the investigation revealed (1) the experimental programs had little differential effect, in comparison to conventional programs, on the attitudes and interests pupils developed toward mathematics, (2) information obtained from the self-report indices indicated that pupils instructed with the Ball State program tended to develop less positive attitudes and interest toward mathematics than those instructed with conventional programs, and (3) there was evidence that the UICSM program, according to the behavioral indices, may have contributed to the development of more positive attitudes and interests than the conventional program. (RP)

BR-5-1028-~~24~~
P.A. 24

FINAL REPORT
Project No. 5-1028
Contract No. OE-5-10-051

EFFECTS OF MODERN AND CONVENTIONAL MATHEMATICS CURRICULA ON PUPIL ATTITUDES, INTERESTS AND PERCEPTION OF PROFICIENCY

January 1968

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

Final Report

Project No. 5-1028
Contract No. OE-5-10-051

Effects of Modern and Conventional Mathematics Curricula on Pupil Attitudes, Interests and Perception of Proficiency

James J. Ryan

Minnesota National Laboratory
Minnesota State Department of Education

St. Paul, Minnesota

January 1968

The research reported herein was performed pursuant to a contract with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

PREFACE AND ACKNOWLEDGMENTS

This project was initiated and carried out in conjunction with an extensive investigation of the effects of several recently developed programs in secondary mathematics on pupil achievement in mathematics. The achievement evaluation project, which was funded by a grant (25164) from the National Science Foundation, was initiated by Professor Paul C. Rosenbloom whose suggestions concerning the need for and form of a related project concerned with the effects of the experimental programs on pupil attitudes and interests were the basis for the present project. His guidance and recommendations in this regard are gratefully acknowledged.

In addition the following persons made professional contributions to the conduct of this project of a specialized and/or extensive nature which are gratefully acknowledged:

Mrs.Gladys Allen, Professional Librarian, who surveyed the school library holdings in mathematics and selected the supplementary library materials distributed to the schools in connection with the library reading project.

Mrs. Edith Mendelson, secondary level mathematics teachers, who had responsibility for selecting, editing, and organizing the content of the mathematics activity bulletin.

Professor Gerald R. Rising, Professor of Mathematics Education, S.U.N.Y. at Buffalo, who provided general consultation on a number of aspects of the project and assisted with the mathematics activity bulletin study.

Mr. Rodney L. Rosse, Research Associate, who in addition to having major responsibility for organizing and processing the questionnaire data, developed computer programs for the appropriate statistical techniques for the complex analyses necessary for that facet of the project.

Mr. David L. Klemmack, Graduate Research Assistant, who carried out a wide variety of data organization, processing, and analysis tasks.

Other graduate research assistants who contributed to this project were: Chaur C. Chen, Clifford Carlson, Paul Curnow, Shelby Hockert and Eugene Lenarz.

Very capable clerical assistance was provided by Sharon McDonough, who maintained records of the participant teachers and classes, and had clerical responsibility throughout the project for preparing the data gathering instruments and the varied communications to participants.

TABLE OF CONTENTS

I. SUMMARY

This project was carried out to determine the effects of three experimental "modern" programs in secondary mathematics, the Ball State, UICSM, and SMSG programs, on the attitudes and interests pupils develop toward mathematics and to examine factors and conditions related to these effects.

The project consisted of a number of separate studies which altogether involved 126 pairs of secondary mathematics classes in schools distributed over a five-state area: Minnesota, Wisconsin, Iowa, North and South Dakota. Each pair of classes was instructed by the same teacher, one class with one of the experimental programs, the other with a conventional program. Although some consideration was given to tenth and eleventh grade programs, the project focused mainly on programs and classes at the ninth grade level.

Comparisons were made between pupils instructed with experimental and conventional programs in terms of a number of separate indices of attitude and interest. Self-report indices representing measures of general interest in mathematics and of specific attitude and interest dimensions, including the pupil's perception of his own proficiency, were obtained from questionnaires administered at the beginning and end of the school year. These indices were based upon expressed feelings, judgments and beliefs concerning mathematics as a school subject and an area of activity. At the same time, pupil reactions and judgments concerning attitude relevant instructional factors and conditions were also obtained. The questionnaire data was gathered from separate samples of ninth grade classes during each of two years.

Systematic observations were also made of overt behavioral manifestations of pupil interest in mathematics subsequent to instruction with the programs being compared. To make these observations, the necessary conditions and procedures were carried out in separate studies using classes instructed during several different years. Comparisons were made using the following overt behavioral indications of pupil interest:

1. Response to opportunities to obtain recreational materials concerned with mathematics.

2. The amount of reading of library materials concerned with mathematics.

3. Subsequent enrollment in advanced mathematics subjects in high school.

In connection with all of the comparisons, consideration was given to such possibly relevant pupil characteristics as sex and level of proficiency in mathematics and in some instances the mathematics grades pupils had received prior to and concurrent with instruction with the

programs being compared. Also the amount of teacher experience with and separately their judgments about the experimental programs they were teaching were examined as factors that may have contributed to or modified program differences observed with the self-report indices.

With respect to changes in attitudes and interests in general, there were no large or consistent differences for any of the experimental programs over the range of indices and samples of pupils considered in the project. Rather the results indicated that the experimental programs had little differential effect, in comparison to conventional programs, on the attitudes and interests pupils developed toward mathematics over the period of instruction with these programs.

However, among the differences that did occur for two of the programs, some were sufficiently consistent to suggest certain tendencies with respect to attitudinal effects of these programs. Results obtained from the self-report indices indicated that pupils instructed with the Ball State program tended to develop less positive attitudes or interests toward mathematics than those instructed with conventional programs. The clearest and most consistent difference in this regard was on an index of intrinsic interest in mathematics. For the UICSM program there was evidence, mainly from the behavioral indices, that this program may have contributed to the development of more positive attitudes or interests than the comparison conventional program. One such indication was a somewhat higher frequency of enrollment in advanced mathematics subjects on the part of lower achievement pupils instructed with the UICSM than with a conventional program. For pupils instructed with the SMSG program, the differences were too limited to conclude other than that this program had no discernible differential effect on pupil attitudes or interests.

Overall, however, the differences that did occur for the Ball State and the UICSM programs did not appear to be of sufficient magnitude nor generality to conclude that these programs could contribute more than the conventional programs to any strong or long range shifts in pupil attitudes or interests which might not be fairly readily modified by subsequent factors or conditions.

Consideration of pupil reaction to certain qualities of their instructional materials did reveal under some conditions a moderately large differential judgment with respect to the difficulty of the instructional materials. Pupils instructed with the Ball State program consistently reported greater difficulty using and understanding their textbooks than did comparison pupils instructed with conventional materials A similar difference occurred for those instructed with the SMSG program but the large amount of variation between teachers with respect to this difference precluded any generalization beyond the sample A similar difference did not occur for pupils using the UICSM materials. Further analyses showed that this reaction to the instructional materials could account for the less positive attitudes developed by the Ball State pupils. The evidence did not suggest, however, that in the absence of greater difficulty with the materials, pupils instructed with the Ball State program would have developed more positive attitudes in comparison to those instructed with conventional materials. It appears then that pupils instructed with the Ball State program would be somewhat more likely to experience greater difficulty using and understanding their materials than those instructed with conventional programs.

There was no evidence that logically relevant teacher or pupil characteristics contributed to any consistent variation in the more generally observed instructional program differences that were obtained.

In consideration of factors that may have contributed to these results, it was found that the lack of larger instructional program differences was not the result of a limited amount of attitude change in general since on the self-report indices, a reasonably large amount of attitude change did occur. Two factors that were identified which could independently account for a moderate proportion of attitude change _in general_ were change in grade received relative to the previous year and the experienced difficulty with the instructional materials. The latter appeared to have a greater affect on change in intrinsic interest in mathematics, while a change in the grades a pupil received related quite highly to a change in the pupil's perception of his competence in mathematics. Evidence was obtained therefore which indicated that in general a quality of the instructional materials, as such, textbook difficulty, could have an effect on some dimensions of pupils' affective reactions to mathematics.

II. INTRODUCTION

The primary purpose of this project was to determine the extent and nature of the effects of several recently developed experimental programs in secondary mathematics on the attitudes and interests pupils develop toward mathematics. The study was carried out by comparing the affective outcomes for pupils in mathematics classes instructed by the same teachers with either a conventional or an experimental program. The indices used were based upon the pupil's expressed feelings and preferences for mathematics as well as the degree of overt behavioral involvement in activities concerned with mathematics. The instructional programs were experimental versions that resulted from several recent curriculum revision and development activities in secondary mathematics and as such represented prototypes of what has come to be called "modern" mathematics.

The development of positive attitudes and interests with regard to the content of any subject matter area is usually one of the main instructional objectives emphasized by educators and curriculum developers. This is because the pupil's attitudes and interests directly affect, if not represent, the motivational basis for acquisition and performance in connection with the subject matter. These affective reactions also influence the individuals readiness or tendency to utilize the acquired knowledge and skills in appropriate future situations as well as his disposition toward future instruction in the content of the subject matter areas.

Developers and proponents of newer programs in mathematics have suggested that these programs might result in more positive pupil attitudes and interests than the traditional programs in mathematics. Such effects might be expected in part because of several objectives which guided the development of the experimental programs. Among these were (1) an attempt to provide more powerful general concepts and principles which have broader applicability and require less emphasis on the development of specific manipulative and computational skills requiring monotonous and repetitive drill; (2) emphasis on active pupil participation in the learning process and "discovery learning"; (3) presenting problems and concepts in more meaningful and relevant situations and contexts. An indication of the outcomes in the area of pupil attitude anticipated for the newer programs in mathematics is provided in a recent statement by a noted mathematics educator (9 , p. 236).

> "Finally, another learning outcome, a noncognitive one, is the appreciation and esthetic satisfaction that derives from the knowledge and use of mathematical concepts. One of the main points in favor of the contemporary conceptualization and teaching of mathematics is in its stress of discovering meaningful concepts as opposed to memorizing rules and procedures. Perceptual-intuitive abstracting of concepts from physical situations, with unhurried calm, has motivated children to learn and enjoy the learning of mathematics. This will lead, on the part of many learners, to extended study of the subject."

That these objectives might have been achieved is suggested by another mathematics educator in his characterization of the initial reactions to one of the programs (16 , p. 135).

> "Students who have used SMSG materials appear to have reacted very favorably. Since it began testing its sample textbooks, SMSG has obtained thousands of detailed reports on the experiences of teachers using the experimental versions of the textbooks. Each of the reports covered one chapter of one book. Among items discussed by these teachers were some concerning the attitude and behavior of the students in the experimental classrooms. In overwhelming numbers, these teachers reported that students seemed more interested in studying mathematics than they formerly had been, and that classroom sessions were very stimulating and challenging to teacher and student alike. Given a choice, a great majority of these students stated that they would prefer to continue studying mathematics from SMSG materials."

On the other hand, some evidence that the objectives with respect to pupil attitudes may not have been achieved to the extent intended is given in a report of a systematic study in this area carried out in connection with the SMSG program by Alpert, Stellwagon and Becker (2).

A secondary purpose of this project was to examine the relations among a number of attitude relevant variables and performance indices to obtain an indication of some of the factors that, in general, contribute to or affect the development of pupil attitudes and interests in mathematics in addition to or in conjunction with instructional program variations.

The experimental programs were those developed for the ninth, tenth, or eleventh grade levels under the auspices of the Ball State Indiana Teachers College (Ball State); The University of Illinois Committee on School Mathematics (UICSM); and The School Mathematics Study Group (SMSG).

The objectives of this project were then:

1. To determine the relative effects of each of several experimental of "modern" secondary mathematics programs on the attitudes and interests pupils develop toward mathematics when compared to conventional programs otherwise in use.

    a) To make these comparisons on indices derived from overt behavioral involvement and on self-report indices based upon expressed preferences, feelings, beliefs and judgments concerning mathematics as a subject and an area of activity.

b) To include among the self-report indices those reflecting more general or global attitudes and those reflecting specific attitudinal dimensions or components such as the pupils' perception of his own proficiency as well as attitude relevant factors such as learning difficulty.

2. To examine both pupil sex and mathematics ability level as factors moderating the instructional program effects.

3. To determine the nature of the relations among the various indices of mathematics attitudes and interests and indices of achievement.

A. Conceptual Considerations

1. The assessment of attitudes and interests

There are a variety of ways in which attitudes, interests, and affective reactions in general can be manifested. In connection with educational objectives, Krathwohl, Bloom and Masia (10) have made distinctions between and characterized a range of affective reactions and have suggested various means by which such instructional outcomes could be observed and assessed. However, in general, the grossest distinction is between engaging in behavior involving actual time and effort directed toward one of several alternative areas of activity and the symbolic expression of an affective reaction from which can be inferred a preference for or willingness to engage in that activity. The latter which is usually measured by the individual's verbal report of his reactions, in terms of beliefs, judgments, preferences, etc., does not in itself require any real behavioral commitment in terms of time and effort.

Independent of the manner in which it is manifested, it is reasonable to assume that an individual's more general affective disposition toward a given situation, event, etc., is a composite or resultant of a number of more specific separate attitude relevant factors or elements. Although a general affective reaction might be conceived of as being at some point along an evaluative continuum, it probably reflects a number of underlying dimensions or components which differentially contribute to its resultant value. The underlying dimensions or components are likely to have developed independently, to be differentially affected by environmental events or conditions, and to contribute to variations (between persons within situations, and within persons between situations) in the ways in which an attitude is manifested. It is possible that the not infrequently observed lack of a high degree of correspondence between separate indices of the same general attitude (i.e. of reaction to the same attitude object) is a result of fact that the separate indices do not tap to the same degree the separate underlying attitudinal dimensions or elements. Consequently, investigation of the affective reactions pupils develop with respect to the content of a given subject matter area should consider not only the general reaction but also the more specific factors that may differentially determine the nature of the response at the general level, that is, some of the dimensions of the more general resultant reaction. Observation of the more specific attitudinal factors or components provides the possibility of obtaining more sensitive indicators of the effects of instructional variations which might otherwise be masked if only a composite response were observed as well as the possibility of obtaining an indication of the basis for any general affective differences that are observed.

The existence of component factors underlying a general affective reaction also suggests that no single overt behavioral indication of an attitude would necessarily be sufficient to detect attitudinal variations that can occur along several dimensions. It would suggest rather that observation of attitudinal effects be made in several situations which vary somewhat in the type and nature of the involvement they require.

Consequently to assess a broad range of possible outcomes which would provide a maximal opportunity for any distinctive attitudinal effects resulting from the experimental programs to be indicated, both types of attitude and interest indices were used in this project; overt behavioral indices based upon the individuals actual involvement in activities representative of a positive attitude or interest in mathematics, and indices based upon the individuals subjective expression of feelings, beliefs, judgments, and preferences concerning mathematics as a school subject and as an individual skill and an area of activity.

Other differences between these two types of indices were also relevant to their use in this project. Attitude indices based upon actual behavioral commitment or involvement are often considered to be more objective and intrinsically valid, on logical grounds at least, than expressed reactions. However the kinds of situations in which behavioral indications of attitude could be obtained usually permit only a gross distinction as to the intensity of the attitude, i.e. differentiating between those who respond in the direction of involvement and those who do not. Indices derived from expressed reactions on the other hand, because they are constructed to yield continuous values, usually permit finer distinctions along a continuum of attitude intensity and thereby provide a more sensitive assessment of attitude differences. For related reasons, it was also easier to develop indices focused explicitly on some of the more specific underlying attitude dimensions using expressed reactions rather than locating or constructing overt behavioral situations to reflect a specific attitudinal dimension.

Another methodological consideration was the degree to which the attitude indices being used reflected pupil attitudes and characteristics other than those of primary concern. The attitudinal factors of main concern were those which reflected most clearly the pupil's affective reaction to the subject matter content of mathematics as such, that is the reaction to those qualities and characteristics most distinctively associated with mathematics content either as a school subject or as a focal activity in or out of school.

With reference to the motivational basis for an individuals' overt participation or involvement in a certain area of activity, a distinction has often been made between intrinsic and extrinsic interest. Intrinsic interest in an activity is usually defined in terms of the extent the individual will choose to engage in the activity independent of the implications or outcomes of such actions or participation beyond the satisfaction derived from so doing. In brief, an indication of preference for an activity because of the nature of the activity itself. In contrast, extrinsic interest refers to participation in an activity to the extent that such participation is expected to facilitate a separate objective or goal, i.e. the participation being a means to an end rather than an end in itself. In these terms intrinsic interest would seem to represent one of the main motivationally relevant objectives of an instructional program in that it refers to the pupils reaction to the instructional materials and subject matter content as such. Applying this distinction to pupil interest in the content of various school subjects, a pupil could be considered to have stronger intrinsic interest in a given subject to the extent that he engages in activities involving the content or skills representative of that subject when doing so provides no tangible external rewards, e.g. higher grades, praise from teachers, etc. Therefore, in connection with the procedures and observations used to obtain indices of actual behavioral involvement, an attempt was made to minimize the effects of such extrinsic factors on pupil response.

Similar considerations were also required for the self-report indices of attitude and interest derived from expressed reactions. The main objective of the study presumed the existence of at least a general affective reaction factor which was measurably independent of other logically distinguishable pupil characteristics that have been frequently observed to be major determinants of pupil behavior. General academic ability or proficiency as indicated by achievement tests and grades and academic achievement motivation in the sense of a positive attitude toward school and school achievement are two such individual difference factors which have frequently been found to account for a large amount of variation in pupil behavior in the school situation. The latter factors were likely to be reflected in and related to the mathematics attitude indices in terms of which the instructional program comparisons were to be made. It was necessary therefore to make the comparisons taking into account and controlling for the effects that might result from pupil differences on these related concommitant factors. This was accomplished for the most part through the type of statistical analyses used to make the comparisons. In this regard, it was assumed that these factors represented pupil abilities and past experiences as they existed at the beginning of the school year and as such would be reflected effectively to the same degree in both pre and post indices of mathematics attitudes. Taking into account in the analyses variations on the premeasure of a given attitude index would thereby control for the effects of these and related factors.

A similar question at a different level also existed for the several specific attitude and interest indices (as contrasted to more general or global indices of interest) which were developed within the project to measure the more specific component attitudinal dimensions. One aspect of this question which is more evident for these indices concerns the extent to which they were assessing empirically independent attitudinal factors or dimensions. Since these indices were developed within the project, it was possible to minimize their reflecting common factors through procedures used in their development. Nonetheless some consideration was given to this question which essentially concerns the construct validity of the various indices that were used.

2. Instructional program effects

Differences observed on an attitude measure between experimental and conventional (E and C) class pupils when the initial characteristics of pupils in the alternate instructional groups were equated, either statistically or otherwise, could be attributed to differences in the instructional conditions or experiences of the separate groups of pupils. Even though the instructional materials represented the main difference between the alternate groups and the design required that the same teachers instruct both experimental and conventional classes, other attitude relevant instructional factors or conditions may have differed in some consistent or systematic way to contribute to or determine attitude differences between experimental and conventional class pupils. Among the factors or conditions that might vary with the instructional materials were those that could have a direct and those that could have an indirect effect upon pupil attitudes. The direct effects would be those resulting from the pupils' interaction with the materials, as such, relatively independent of other factors in the instructional situation. That is those qualities and characteristics of the materials which, as they are used by the pupils, influence the pupils' affective reactions or attitude toward mathematics. Among these might be such characteristics as novelty, ease or difficulty of comprehension, or linkage of the content to areas of relevant application for the pupil. The indirect effects would be those that resulted from changes in other instructional factors or conditions that were more directly affected by the instructional materials being used. Teachers' attitudes toward the materials, their grading practices, or their demands upon pupil performance if they varied between E and C classes could be possible sources of such indirect effects. The assertion of those suggesting that the newer curricula might make a greater contribution to attitudes toward mathematics appears to imply that such outcomes are primarily the result of direct rather than indirect effects. Consequently, in the analysis consideration was given to and a distinction made between factors that might represent direct and indirect effects of the instructional materials. Among the former, data concerning pupil judgments or reactions to the materials were gathered and among the latter, information concerning teacher's attitudes toward the materials and pupil grades were obtained. From a methodological point of view, however, because of their interaction over time and because these effects would not be independent, it could be difficult to determine the order of effect or causal sequence for such concommitant factors with respect to attitudinal outcomes.

In addition to the question of the general effects or differences for the experimental programs being examined, there is also the question of possible variations in effects or outcomes under different instructional conditions or for different subgroups of pupils. This is a question of factors or conditions that might moderate the effects of the various instructional materials. Among the factors considered as moderator variables were such pupil characteristics as sex and level of mathematics ability as well as the amount of teacher experience with the experimental program. This set of factors should be distinguished from those considered previously as conditions affecting or mediating the attitudinal outcomes in that differences for the latter variables arise during the instructional period while those characterized as moderator variables represent conditions existing prior to instruction. The causal sequence of effect for the moderator variables would be more evident while the order or direction of effect for conditions occurring or at least observed during the instructional period could only be inferred in conjunction with certain assumptions.

III. GENERAL METHOD

A. Sample

The classes included in this study were those available as part of a more extensive field study of the effects on achievement of several experimental programs in secondary mathematics.[1] In connection with the achievement study, teachers taught two participant classes at the same grade level, one with one of the experimental programs, the other with the usual conventional program.

[1] Study of Secondary Mathematics Curricula, Supported by a grant (G25164) from the National Science Foundation, Paul C. Rosenbloom, Project Initiator

The participant teachers were in schools distributed over a five state area, Minnesota, Iowa, Wisconsin, North Dakota and South Dakota. The greatest majority were in less populated communities rather than the larger metropolitan areas in this region. Participation was voluntary on the part of both teachers and school administrators. In addition to using the alternate programs in the two classes, participation in the achievement study consisted of the administration of designated mathematics achievement tests to both classes at the beginning and end of each school year. Teachers initiated, and in a certain proportion of cases continued, their participation during any of four successive school years from 1962-63 through 1965-66. Except for a sample of ninth grade classes of teachers participating during 1962-63, included in the follow-up enrollment study, the classes were those of teachers participating in the 1964-65 and 1965-66 years.

Because the achievement evaluation project being carried out with the experimental materials had been underway for several years, teachers participating in the 1964-66 years had varying amounts of previous experience with the experimental program they were using. Also because of the voluntary nature of their participation, there were a different number of teachers using each experimental program and, therefore, the number of pairs of E and C classes, as well as the number of previous years experience the teachers had with the experimental program, varied among the experimental program comparison conditions.

The project focused mainly on programs and classes at the ninth grade level although for one study observations were also made among tenth and eleventh grade classes.

As part of the procedure involved in participation in the achievement evaluation project, principals and teachers had been requested to assign pupils to the alternate classes on a random basis. That this was not accomplished for a few of the classes, inadvertently or otherwise, was evident from the distribution of initial achievement test scores. In the samples of classes for which this was evident, these classes were not included in the related analysis. The classes generally however, did represent a fairly wide range in level of mathematics achievement at the beginning of the year.

B. General Procedures

To obtain the necessary observations and indices several separate samples of classes were used. The main reason was to avoid making too many demands with respect to data gathering procedures on any one set of teachers or classes. Also, however, for some classes it was possible to gather only certain kinds of data and in some instances it was desirable to avoid confounding the possible effects of separate data gathering procedures.

The project consisted then of a number of semi-independent studies for which there was some overlap with respect to the classes from which the data was gathered. For each of the different studies which differed usually in the type of attitude indices used, there were differences in the class samples and in the procedures for data gathering and analysis. Consequently, the specific characteristics of the sample of classes, the specific data gathering and analysis procedures that were followed, and the results obtained will be presented separately below in connection with each study.

The general procedures followed for each of the studies consisted of:

(1) Identifying teachers (and schools) at each grade level participating in the achievement evaluation project by teaching one class with one of the E programs and a separate class at the same grade level (i.e. concerned with the same mathematics subject) with the conventional program that was otherwise being used by that teacher.

(2) Contacting both the principal of the school and the participant teacher to (a) provide a general characterization of the purpose of the study (in terms which did not suggest any between class or school comparisons or evaluations) (b) to outline the data gathering activities and procedures that would be required and (c) to request their cooperation and assistance with the gathering of data. Appropriate assurance was provided concerning the confidentiality of the data and that neither pupils, teachers, nor schools would be identified in reports of results. Only a small proportion of schools or teachers were unwilling to cooperate in any of the studies

(3) Providing the actual data gathering materials with whatever procedures and instructions were necessary for so doing.

In connection with procedures for some of the studies additional information was obtained or subsequent contacts were made with the appropriate school personnel to check on the extent to which the procedures were adhered to. In almost every instance, the participant teachers or school personnel were found to have followed the instructions and procedures very closely.

Table 1 shows the grade levels, the number of teachers (i.e. pairs of classes) in each experimental program comparison condition and the year of participation for each of the separate studies which have been characterized in terms of the type of attitude index used.

TABLE 1

Description of Grade Level, Year and Number of Class Pairs in each Study

Type of Attitude Index	Grade Levels	Years Instr. With E Progr.	Number of Class Pairs In E Program Condition: Ball State	UICSM	SMSG
Request for mathematics activity bulletin	9	{ 1964-65	3	2	5
	10	{	5	2	17
	11	{	14		12
Library reading					
- in schools receiving additional materials	9	1964-65	4	3	4
- in schools not receiving additional materials	9	1964-65	7	6	13
Subscription to Mathematics Student Journal	9	1964-65	2	3	4
Enrollment in advanced mathematics					
- Study I	9	1962-63	7	5	9
- Study II	9	1965-66	4	6	7
..stionnaire, self-report s					
irst year	9	1964-65	11	9	17
Second year	9	1965-66	5	6	5

C. Experimental materials

The experimental materials used in the alternate experimental classes were those developed under the auspices of the Ball State Indiana Teachers College, The University of Illinois Committee on School Mathematics (UICSM), and the School Mathematics Study Group (SMSG). The specific ninth grade textbooks for each of these programs were respectively: Algebra I by Brumfiel, Eicholz and Shanks, Addison-Wesley, Mass. 1961; High School Mathematics Units 1-4, Revised Edition, Illinois Committee on School Mathematics, University of Illinois Press, Urbana, Ill., 1962; First Course in Algebra, School Mathematics Study Group, Yale University Press, New Haven, Conn., 1962. These programs are for the most part prototypes of what has been commonly characterized as "modern" mathematics.

IV. INSTRUCTIONAL PROGRAM EFFECTS INDICATED BY SELF-REPORT INDICES OF ATTITUDE AND INTEREST

This facet of the project was directed toward providing an assessment of a broad range of possible attitudinal effects which on logical grounds appeared likely to be influenced by the alternate programs and/or related conditions of instruction. These effects were examined using self-report indices measuring both the general affective reactions of pupils as well as more specific attitude and interest components and factors and other attitude relevant conditions.

The procedure followed was to administer questionnaires including the various indices at the beginning and end of the school year to pairs of ninth grade algebra classes taught by the same teachers, one class with one of the several experimental programs, the other with the teacher's conventional program.

Comparisons were made between pupils in classes receiving the alternate instructional programs in terms of their questionnaire responses. Since these effects could vary with other conditions of instruction or pupil or teacher characteristics; pupil sex, measures of achievement and grades in mathematics, pupil judgments of relevant instructional conditions, and teacher experience with, and evaluation of, the experimental programs were considered in the analysis.

This study was carried out for each of two separate years with data being gathered from separate samples of pupils each year. The procedures and results for each year will be presented separately. The first year study included a larger sample of classes (and teachers) in each of the three experimental program comparison conditions.

The second year study was intended as replication of the first year study with some modifications in the measuring instruments and the analysis design. It was carried out to determine the generality of the results obtained from the first year study and to enable more direct tests of hypotheses generated from the results and analysis of the first year data.

A. First Year Study

1. Method

a. Sample and data gathering procedures

The sample from which data was gathered consisted of 37 pairs of classes receiving instruction in ninth grade algebra during the 1964-65 school year; each pair being taught by the same teacher in connection with his participation in the project investigating the achievement effects of the experimental programs which was described above.

Initial achievement scores obtained for the classes as well as questionnaire information from the participant teachers provided an indication that five homogeneously grouped classes (some high, some low ability) among those that would otherwise be included in the data analysis sample. Since such grouping could in itself be a source of certain differential attitudes and reactions between a pair of classes, both classes (E and C) for teachers having a homogeneously grouped class were, therefore, eliminated from the analysis directly concerned with the instructional effects. Four of these teachers were using the SMSG program and one the Ball State program.

Table 2 shows the number of teachers included in the analysis sample following each experimental program in their E class and the number of previous years experience with that program.

Table 2

Number of Teachers Following Each E Program and the Number of Previous Years Experience With That Program

Number of Previous Years	Ball State	UICSM	SMSG	Total
2	5	2	2	9
1	4	4	4	12
0	1	3	7	11
Total	10	9	13	32

Principals and teachers were contacted at the beginning of the school year and requested to cooperate in the data gathering aspects of this project. Upon indication of their willingness to do so, principals were requested to make arrangements for the questionnaires to be administered in the two mathematics classes by someone other than the teacher (preferably an administrator or counselor). Forms filled out by those administering the questionnaires indicated that they complied with this request in every instance.

The questionnaires incorporating the various measuring instruments were distributed to the schools for administration approximately 5 - 6 weeks after the beginning of the fall term. Most were administered within a week after their receipt. Revised questionnaires were again distributed for administration following the same procedure within the last two or three weeks of the spring term.

b. Instrumentation

i. Attitude and interest indices

Data was obtained on a number of separate indices of attitudes and interests in mathematics which were based upon pupils' expressed feelings, preference, judgments and/or beliefs concerning mathematics as a school subject or as an area of activity.

The self-report indices were of two types; those previously developed outside of the present project which appeared to represent measures of a pupil's more general or global interest in mathematics and those developed within the present project to measure more specific component dimensions or factors underlying the attitudes toward or the interest in mathematics. The latter were developed to assess certain specific logically independent attitude or interest relevant factors or attitudinal components that seemed likely to be affected by variations in instructional conditions and which, consequently, might contribute differentially to the pupil's overall affective reaction or general attitude or interest with respect to mathematics. The instructions and items for each of these indices are shown in Appendix A.

The two previously developed measures of general interest in mathematics were the following:

> The Aiken Mathematics Interest Scale (A scale), a twenty item Likert type scale in which the respondent indicates from among five alternatives, ranging from "strongly disagree" to "strongly agree", the extent of agreement with each of the statements provided concerning mathematics. The responses are logically keyed with response weights from 1 to 5 in the direction of a positive attitude toward mathematics. This scale was developed and reported by Aiken (1).
>
> The Dutton Mathematics Attitude Scale (D scale), is a twenty-one item Thurstone type scale developed and reported by Dutton (8). This scale is made up of statements representing varying degrees of positive and negative feelings, opinions or judgments about mathematics. The statements have weights determined by an a priori scaling procedure using judges familiar with the attitude or interest dimension being measured. Respondents were instructed to indicate those statements with which they most strongly agreed. Their score was the average of the weights of the items they selected.

Indices to measure the more specific factors or components of mathematics attitudes and interests were developed in the following way. Questionnaire items were constructed to obtain judgments, perceptions, feelings or reactions reflecting each of a number of attitudinal dimensions or attitude relevant instructional factors. These items were included in the questionnaire with the same response format being used for each item.

Following administration of the questionnaire, responses to each item were intercorrelated and the resulting correlation matrix factor analyzed using a principle components solution rotated to Kaiser's normal vari-max criterion. The correlations and factor analyses were used to identify items among those constructed for each of the indices that had similar factor loading patterns[2] and that would provide the

[2] It should be pointed out that the orthogonal factors resulting from the factor analysis were not used directly to define the attitude dimensions to be measured by the items nor was any construct interpretation of these factors attempted.

highest intrascale and lowest interscale correlations. This resulted in some items being excluded from the indices for which they were constructed and some intended indices being dropped from further consideration because the items were found not to be sufficiently independent of those in other indices to warrant consideration as a separate dimension.[3] The items included in each of the resulting indices were those exhibiting higher intrascale item correlations and factor pattern similarity than those in alternate indices. Each indices also gave evidence of reflecting factors sufficiently independent of other indices to be considered a separate dimension. The item analysis and index development activities were carried out for items included in both the beginning and end-of-year questionnaires. The analysis of the initial set of questionnaire items provided the basis for revision of some items and development of additional items to obtain more adequate indices from the end-of-year questionnaire.

The following are the indices developed from the questionnaire items to measure more specific attitude and interest factors.

> Intrinsic interest - Consisting of items concerned with the degree of interest in or preference for activities involving or requiring the use of mathematics.

This scale represented an attempt to get at the aspect of interest that derives from the pupils' reaction to mathematics materials and activities as such in contrast to an interest that derives primarily from performance, competency, or general achievement motivation factors. That is, the degree of preference for mathematics activities independent of extrinsic factors. Items in this index asked explicitly about the pupil's level of interest, and such things as how much he liked doing homework or extra reading in mathematics.

> Perceived knowledge - Items concerned with pupils' judgment about his own knowledge or proficiency in mathematics. This index included items requesting the pupils' judgment of his own proficiency relative to other pupils as well as in absolute terms.

A pupil's conception of his own proficiency in a given subject matter area has often been suggested as a factor relevant to subsequent achievement. Recent evidence presented by Brookover (5) provides direct support for this contention.

> Perceived utility - Items concerned with the extent to which knowledge of mathematics was seen as facilitating achievement of the pupils future goals and objectives, that is "how useful or important" they felt knowledge of the subject was for what they wanted to do later on.

[3] One of these was an index of "perceived gain in knowledge" the items for which could not be distinguished from those in an index measuring "ease of learning."

This index was included in part because studies of factors underlying social attitudes have suggested that perceived instrumentality of utility of the attitude object for achieving valued goals or ends is a relevant factor influencing the intensity of the attitude. (See Rosenberg (12).) In addition, mathematics is often conceived of as a skill which is acquired primarily for practical purposes. This is a characteristic which might be less apparent in the "modern" experimental as compared to the conventional mathematics programs.

<u>Experienced ease or difficulty learning</u> - Items concerned with the ease or difficulty the pupil experienced learning and understanding the material presented in the mathematics class.

Although not obviously an attitude dimension, the pupils' subjective impression of the ease or difficulty experienced in conjunction with the required learning tasks is reasonably a factor quite relevant to the pupil's affective reaction to that subject.

In addition to the items comprising the scales providing direct measures of pupil attitudes and interests, items were also included to obtain indices of instructional factors and conditions which could possibly influence, but less directly reflect, attitudinal effects. Some of these items were incorporated into multiple item scales, others were used as single items. Among these was a multiple item index concerning the amount of homework the pupil engaged in for his mathematics class, i.e., an index of expended effort.

Single item indices concerned with how well the pupil liked the teacher and judgments about the ease of understanding and using their texts were also included. The textbook item was included to obtain a direct pupil reaction to the experimental materials used in the classes.

ii. <u>Response Format and Index Scores</u>

Each of the items included in the above indices was constructed to obtain a response on a graphic scale having appropriate labels at points along the scale which in effect defined the dimension of response. Since the same response format was used for all items, the items prepared for the separate indices were included in the questionnaire as a single set of items following the same response instruction. Pupils were instructed to respond to <u>each item</u> for <u>each</u> of the <u>academic subjects</u> they were taking (which were designated as mathematics, English, social studies, science, and foreign language). For each item, the pupil's response for each subject was made on the same scale that accompanied that item. This form of response permitted each item to be scored for a given subject such as mathematics in two ways; (1) in terms of actual scale units for that position on the graphic scale (g - s) and (2) in terms of the rank position (r - p) for that subject relative to the pupils' other subjects. (Instructions to the pupils and the item format are shown in Appendix A)

One reason this procedure was followed was to eliminate certain types of response bias such as have been characterized as "response set" and/or "response style." (See Rorer (11).) Another consideration was that a more objective frame of reference, which was relatively common or standard for all pupils, would be provided by having pupils respond with respect to several subjects in addition to mathematics. In short, then for each index two scores were obtained; one based upon the graphic scale value of the response to each item, the other score indicating the relative position for mathematics compared to other subjects for each item.

iii. Other measures

Measures of pupil achievement or proficiency in mathematics were also obtained. At the beginning and end of the school year, the mathematics section of the Sequential Tests of Educational Progress (STEP), Level Two, (14) was administered to all classes in the sample. The pupils average grades in mathematics for the previous year, eighth grade, and the concurrent year, ninth grade, were also obtained for approximately 80 percent of the classes in the sample.

One factor in the instructional situation that could affect the pupils' attitudes in addition to the materials used, was the teacher's attitude or judgment concerning the materials. To assess this factor a questionnaire was prepared requesting on a number of specific items, the teachers judgments, feelings, and their characterization of the experimental programs they were teaching. Thirty-five of the thirty-seven teachers in the sample returned completed questionnaires. This questionnaire provided a basis for classifying or scoring teachers in terms of their relative attitudes and judgments about the instructional programs which could be examined for their possible correspondence with the resultant pupil attitudes.

c. Method of Analysis

Pupils in classes instructed with the separate experimental programs were compared with those in classes instructed by the same teachers with a conventional program. Each teacher, therefore, had an E and a C class. Since the main question concerned changes or effects occurring over the school year, it was necessary to take into account the pupils' initial level as observed at the beginning of the school year on each of the outcome variables being considered. This was done by blocking on levels of the premeasure of the dependent variable being analyzed and treating the premeasure as a separate factor in the analysis design which also provided an adjustment for initial differences between comparison groups. To make these comparisons a four-factor partially hierarchal analysis of variance design was used. The four factors were

1. The program used in the E class - the E program comparison condition. Each teacher used one of three E programs, Ball State, UICSM or SMSG.

2. The instructional treatment - whether the class was receiving instruction with an E or a C program.

3. The premeasure control for the dependent variable - two levels determined by the median of the overall distribution of scores were used.

4. The teacher - teachers were nested within the alternate E program comparison conditions.

The instructional treatment and premeasure (or control) factors were crossed with each other and with the teacher and E program factors.

A mixed effects model, with teachers being the single random variable, was used with an unweighted means method of analysis. Use of the unweighted means solution was required because of the varying proportions of pupils in each class falling in the alternate levels or blocks for the premeasure as well as the different numbers of pupils in each class. The latter factors also necessitated adjusting the within-cells error estimate for the unequal frequencies within these cells.

The layout, format model, expected values for the mean squares and details for this analysis design are shown in Appendix B.

Although there was a different number of teachers in the sample following each of the experimental programs, to assess the teacher effects, the analysis design required that an equal number of teachers be represented within each E program condition, i.e. each nested level. This meant that some selection be made among the teachers in the E program conditions having the greater number. Another condition of selection was also necessary due to the rather wide range of class differences observed for many of the premeasures which resulted in some classes having too few pupils in either the high or low levels or blocks on the premeasure to fit the minimal conditions for analysis. Both of these conditions were met by selecting in equal numbers, within each E program condition, those teachers having classes for which the cell frequencies were above the minimum necessary and which exhibited the most balanced proportions with respect to the alternate levels on the premeasure. This determination was made separately for the analysis of each of the dependent variables, i.e. each of the attitude and interest indices, since for each a different premeasure was used. Scores defining the two levels or blocks for the premeasure control variable were established by the median of the distribution of scores on this variable obtained by pupils in all classes.

Among the sources of variation in the four factor analysis design, the treatment main effects and several treatment interactions; program by treatment, treatment by premeasure and treatment by teacher were of primary interest. The treatment main effects represented the degree to which there were E - C differences over all three E program comparison conditions. The treatment by program interaction indicated variation in the E - C differences among the alternate E program (treatment) conditions while the treatment by premeasure interaction indicates a variation in the E - C difference between pupils having higher and lower scores on the premeasure.

The program and premeasure main effects were of less interest. A reliable program main effect would indicate that there were general differences, as reflected in both E and C classes, between the separate sets of teachers using each E program. A reliable premeasure main effect would usually be expected since this would indicate that the differences existing at the beginning of the year on a given measure persisted through the year.

The teacher main effects were also of somewhat less concern since they reflect general teacher differences (within E program conditions) common to both E and C classes and do not, therefore, have any clear implication for the treatment effects. The treatment by teacher interactions were, however, given some consideration in that they would indicate differential treatment effects among teachers.

The four-factor analysis was carried out across all E program comparison conditions to determine the nature of the general instructional treatment effects common to all E programs, and to determine if there were reliable variations in the E - C differences between programs. It was however of equal interest to examine the instructional treatment effects for each of the separate E programs.

For each of the E program comparison conditions, a three-factor analysis was also carried out following essentially the same analysis design as used across all E programs. For the three-factor analysis within the E program comparison conditions, the three factors (instructional treatment, premeasure and teacher) were crossed and a 2 x 2 x t factorial design with t representing the number of teachers was used. Here again teachers were treated as a random variable. The formal model, expected values for the mean squares and details for this analysis design are shown in Appendix B .

For some variables the analysis was carried out for males and females separately as well as for the sexes combined.

2. Results

a. Instructional program differences on attitude and interest indices.

i. Indices of general interest in mathematics.

The means (unweighted for classes) obtained at the end of the year for E and C class pupils in each E program comparison condition on the Aiken Mathematics Interest Scale and the Dutton Mathematics Attitude Scale are shown in Tables 3 and 4 , respectively.

For both of these measures, the four-factor analysis of variance considering all program comparison conditions was carried out. It was found, however, for both measures that one of the homogeneity of variance

TABLE 3

Aiken Mathematics Interest Scale: Mean Scores for Pupils in E and C Classes

All pupils 9 pairs E and C classes in each E program condition.

E Program	Treatment / Premeasure level	E low	E high	E ave.	C low	C high	C ave.
Ball State.		2.87	3.69	3.28	3.03	3.90	3.46
UICSM		2.96	3.71	3.34	2.77	3.90	3.33
SMSG		2.72	3.73	3.23	2.91	3.72	3.32
Average all programs		2.85	3.71	3.28	2.90	3.84	3.37

Males 5 pairs E and C classes

E Program	Treatment / Premeasure level	E low	E high	E ave.	C low	C high	C ave.
Ball State		3.04	3.69	3.37	2.99	3.77	3.38
UICSM		2.96	3.96	3.46	3.17	3.79	3.48
SMSG		3.06	3.72	3.39	2.85	3.93	3.39
Average all programs		3.02	3.79	3.40	3.00	3.83	3.41

Females 7 pairs E and C classes

E Program	Treatment / Premeasure level	E low	E high	E ave.	C low	C high	C ave.
Ball State		2.86	3.29	3.06	2.84	3.78	3.31
UICSM		2.93	3.79	3.36	2.56	4.11	3.33
SMSG		2.73	3.61	3.17	2.78	3.80	3.29
Average all programs		2.84	3.56	3.20	2.72	3.89	3.31

TABLE 4

Dutton Mathematics Attitude Scale: Mean Scores for Pupils in E and C Classes

All pupils 8 pairs E and C classes in each E program condition.

E Program	Treatment / Premeasure level	E low	E high	E ave.	C low	C high	C ave.
Ball State		5.10	6.60	5.85	5.02	6.85	5.94
UICSM		5.19	6.56	5.88	4.85	6.81	5.83
SMSG		4.54	6.92	5.73	4.87	7.38	6.13
Average all programs		4.95	6.70	5.82	4.91	7.02	5.97
Males 7 pairs E and C classes							
Ball State		5.41	6.97	6.19	5.55	6.96	6.26
UICSM		5.25	6.72	5.99	5.23	6.56	5.90
SMSG		5.33	6.79	6.06	5.36	6.87	6.11
Average all programs		5.33	6.82	6.08	5.38	6.80	6.09
Females 7 pairs E and C classes							
Ball State		4.58	6.32	5.45	4.80	6.70	5.75
UICSM		5.22	6.22	5.72	4.18	7.00	5.59
SMSG		4.34	6.09	5.21	4.67	6.44	5.56
Average all programs		4.71	6.21	5.46	4.55	6.71	5.63

assumptions[4] was rejected. This precluded an appropriate test of the treatment effects with the design which included all E program conditions. Consequently, only the analysis within each of the E program comparison conditions with the three-factor analysis of variance design was used to obtain an indication of the instructional treatment effects.

The results of the separate analysis for each E program comparison condition for each sex separately and combined are shown in Table 5 .

For the Aiken Scale, the analyses within each program comparison condition for all pupils indicated no significant instructional treatment main effects. For the UICSM comparison a significant treatment by premeasure interaction was obtained. The analyses within the UICSM program comparison for males and females separately indicated that this effect was highly significant for girls but non-significant for boys. A test of the E - C differences for UICSM girls within each of the initial interest levels showed that in the low interest level the E class mean was reliably higher ($F = 4.4$, $p < .05$) than that for the C classes, but that for those having initially higher interests, the difference in favor of the C class girls did not quite reach the .05 level of reliability ($F = 3.2$, $.05 < p < .10$).

For the analysis within each E program condition for the Dutton scale the only reliable treatment effect observed was a treatment by premeasure interaction for girls in the UICSM comparison. As was observed on the Aiken scale, among girls having lower interest scores at the beginning of the year, those instructed with the UICSM program had higher post instruction scores than those in the C classes while the difference was in the opposite direction for those having higher pre instruction interest scores. A test of the differences between each E - C mean within the premeasure levels indicated that for the lower level the E class mean was reliably greater than the C class mean ($F = 11.1$, $p < .01$) while for the higher level, the C class mean was reliably greater ($F = 6.1$, $p < .05$) than that for the E class.

The scales providing a more general or global measure of mathematics interest did not reveal any consistent overall differences between pupils instructed with any of the experimental programs and those instructed with conventional programs.

The only statistically reliable program differences were observed for girls in the UICSM comparison. On both the Aiken and Dutton scales, among girls having initially lower interests, those in UICSM classes had the higher mean interest scores while for girls with higher initial interests those in the comparison conventional classes had the higher means.

[4] The homogeneity of variance assumption was that for the teacher by treatment interaction term required for the treatment effects test which indicated that there was a significant ($p < .01$) difference among the separate within E program condition variances that for the four-factor design had to be pooled to estimate this interaction effect.

TABLE 5

F-ratios From the Analysis of Variance for the Aiken and Dutton Scale Scores Within Each of the E Program Comparison Conditions

E Program	Source of Variance	d.f.	Aiken All Pupils	Aiken M	Aiken F	Dutton All Pupils	Dutton M	Dutton F
Ball State	Treatment	1	3.0	0.0	1.5	.3	0.0	1.0
	Premeasure	1	88.4***	27.5***	25.7***	105.4***	31.7***	51.5***
	Tr X Pre	1	0.0	.2	3.7	.5	.1	.1
	Teacher	(t-1)[a]	1.5	1.4	2.6	1.9	2.8*	1.1
	Tr X Te	(t-1)	1.8	.7	2.0	.5	1.4	1.4
	Pre X Te	(t-1)	1.3	1.2	.7	.3	.5	.6
	Tr X Pre X Te	(t-1)	2.8**	.9	1.2	1.9	1.8	1.8
	Error MS		.056	.092	.128	.210	.488	.451
	df		327	91	109	298	109	131
UICSM	Treatment	1	0.0	0.0	.1	.1	.1	.2
	Premeasure	1	147.1***	40.0***	90.5***	40.4***	25.7**	75.4***
	Tr X Pre	1	5.7*	2.1	7.6**	3.2	.1	16.8***
	Teacher	(t-1)	1.6	2.3	2.0	1.2	2.0	2.3*
	Tr X Te	(t-1)	.2	.9	.4	.2	.7	2.1
	Pre X Te	(t-1)	.8	.9	.2	2.5*	1.4	.8
	Tr X Pre X Te	(t-1)	.9	1.3	.5	1.1	.7	1.0
	Error MS		.054	.082	.1119	.221	.391	.339
	df		351	95	128	302	133	130
SMSG	Treatment	1	1.6	0.0	.5	1.3	.1	3.0
	Premeasure	1	157.6***	26.9**	71.6***	51.2***	19.6**	79.4***
	Tr X Pre	1	1.0	3.0	.3	0.0	0.0	0.0
	Teacher	(t-1)	1.8	.8	3.6**	.3	.9	1.9
	Tr X Te	(t-1)	.5	.3	2.4*	.4	.6	1.2
	Pre X Te	(t-1)	.4	1.9	1.3	.4	2.2*	.7
	Tr X Pre X Te	(t-1)	1.8	.4	.7	.5	1.5	1.6
	Error MS		.047	.075	.089	.937	.361	.273
	df		392	103	147	327	133	157

* $p < .05$, ** $p < .01$, *** $p < .001$

[a] t = number of teachers (i.e. pairs of classes) indicated in the table of means for each measure.

ii. Indices of specific attitude dimensions

As discussed above, two scores were derived from the items comprising the indices developed to assess specific attitude and interest dimensions or factors. One score was based upon the response value on the graphic scale for the individual items (g - s score). The second score was based upon the response to each item for mathematics relative to other subjects, i.e. the subject rank position for mathematics (r - p score).

(a) Graphic scale scores

Intrinsic Interest - The Intrinsic Interest index g - s score means are shown in Table 6 . The results of the analysis across all of the E program conditions are given in Table 7 .. In the analysis for females alone, there was a significant program by treatment interaction. This effect was a result of the UICSM girls having a higher mean and the Ball State girls having a lower mean than those in their respective conventional comparison classes. The results of the analysis for girls within each experimental program comparison condition, shown in Table 8 , indicated that none of the E - C differences within the separate treatment conditions reached the .05 level of significance.

The significant interaction and the pattern of means indicates, however, that for girls, the intrinsic interest of those in the UICSM program was much more positive relative to the intrinsic interest of girls in the comparison conventional classes than were the interests of girls instructed with the Ball State program compared to those in their comparison classes. No reliable treatment effects were observed in the analyses made for this measure for males or for all pupils combined.

Perceived Utility - The means for g - s scores obtained on the Perceived Utility index are shown in Table 9 . The results of the analysis of variance considering all programs are shown in Table 7 .

A significant program by treatment interaction was obtained for the analysis considering all pupils and considering females alone. This interaction in both instances appeared to be the result of the C class pupils having a higher mean Perceived Utility score in the Ball State comparison and the E class pupils having the higher mean in the UICSM comparison. The within program analysis, (Table 8) carried out for each of the sexes separately and combined, indicated that when all pupils were considered, the E - C differences for both the Ball State and UICSM comparisons were reliable at the .05 level although in opposite directions. The analysis for girls alone indicated only the UICSM E - C difference was reliable. The latter analyses also indicated a significant treatment by prelevel interaction for the UICSM program comparison which was the result of E - C difference in favor of the UICSM classes being larger among girls having lower rather than higher initial Perceived Utility scores. For boys alone, no significant treatment effects were indicated for any of the programs.

TABLE 6

Intrinsic Interest: Mean g - s Scores for Pupils in E and C Classes

All pupils 9 pairs E and C classes in each E program condition.

E Program	Treatment / Premeasure level	E low	E high	E ave.	C low	C high	C ave.
Ball State		2.47	3.44	2.96	2.48	3.38	2.93
UICSM		2.55	3.27	2.91	2.44	3.34	2.89
SMSG		2.46	3.43	2.94	2.47	3.51	2.99
Average all programs		2.49	3.38	2.94	2.46	3.41	2.94
Males 6 pairs E and C classes							
Ball State		2.23	3.50	2.86	2.40	3.45	2.92
UICSM		2.57	3.36	2.97	2.43	3.26	2.86
SMSG		2.54	3.50	3.02	2.34	3.74	3.04
Average all programs		2.45	3.45	2.95	2.39	3.48	2.94
Females 6 pairs E and C classes							
Ball State		2.49	2.94	2.71	2.76	3.35	3.05
UICSM		3.05	3.37	3.21	2.47	2.95	2.71
SMSG		2.46	3.10	2.78	2.37	3.11	2.74
Average all programs		2.67	3.13	2.90	2.53	3.13	2.83

TABLE 7

F-ratios From the Analysis of Variance Over All E Program Comparison Conditions for Each Attitude Index g - s Score for Males and Females Separately and Combined

Source of Variance	d.f.	Intrinsic Interest: All Pupils	Intrinsic Interest: M	Intrinsic Interest: F	Perceived Knowledge: All Pupils	Perceived Knowledge: M	Perceived Knowledge: F	Perceived Utility: All Pupils	Perceived Utility: M	Perceived Utility: F	Ease of Learning: All Pupils	Ease of Learning: M	Ease of Learning: F
Program	2	.2	.4	.5	1.2	1.2	1.5	.4	.4	.3	.8	2.8	.9
Treatment	1	0.0	0.0	.3	3.2	1.4	0.0	1.2	.8	.6	10.5**	1.3	14.2**
Premeasure	1	217.7***	80.3***	17.4***	243.7***	76.1***	114.0***	74.4***	35.3***	43.3***	197.2***	72.6***	100.3***
Pro X Tr	2	.1	.3	3.9*	.8	1.1	1.9	5.4**	.7	3.7*	.3	.2	1.6
Pro X Pre	2	.8	1.0	.4	1.8	.6	0.0	.6	5.4**	0.0	1.4	0.0	3.0
Tr X Pre	1	.2	.1	.4	0.0	.1	0.0	.3	.2	2.2	0.0	1.0	1.0
Pro X Tr X Pre	2	.3	.6	0.0	1.7	.5	1.2	1.1	.4	1.4	1.0	.7	.2
Teacher	3(t-1)	2.3***	2.0*	2.7***	2.5***	.7	2.4***	3.4***	1.3	3.1***	2.3***	.7	2.3**
Number of Teachers	t =	9	6	6	8	6	6	8	5	6	8	6	5
Te X Pre	3(t-1)	1.1	1.4	1.6	1.0	1.1	.6	1.4	1.1	.8	1.3	1.0	1.3
Te X Tr	3(t-1)	.9	.7	1.4	1.0	1.1	1.0	.9	.6	.9	1.0	1.2	1.6
Te X Tr X Pre	3(t-1)	.9	1.6	1.2	1.3	1.5	1.1	1.5	1.4	.9	.9	.4	1.1
Error MS		.104	.181	.189	.436	1.062	.727	.163	.237	.352	.122	.280	.201
df		1106	345	359	968	346	367	1000	300	360	957	341	286

* $p < .05$, ** $p < .01$, *** $p < .001$

TABLE 8

F-ratios From the Analysis of Variance Within Each of the E Program Comparison Conditions for the Intrinsic Interest and Perceived Utility Index g - s Scores

E Program	Source of Variance	d.f.	Intrinsic Interest: All Pupils	Intrinsic Interest: M	Intrinsic Interest: F	Perceived Utility: All Pupils	Perceived Utility: M	Perceived Utility: F
Ball State	Treatment	1	.1	.1	2.7	2.2*	0.0	1.3
	Premeasure	1	67.2**	40.6***	6.6*	49.1***	29.1***	12.5**
	Tr X Pre	1	.1	.4	.1	.4	0.0	.1
	Teacher	(t-1)[a]	3.1***	2.4*	4.4**	1.2	.6	1.0
	Tr X Te	(t-1)	.8	1.0	.6	1.9	1.0	.9
	Pre X Te	(t-1)	.7	1.1	.9	1.2	.1	.8
	Tr X Pre X Te	(t-1)	.3	.5	1.0	1.9	1.5	1.3
	Error MS		.117	.198	.246	.164	.306	.373
	df		342	109	103	305	94	117
UICSM	Treatment	1	0.0	.5	4.0	4.4*	2.6	6.2*
	Premeasure	1	57.5***	11.9*	1.8	19.9***	3.2	14.3**
	Tr X Pre	1	.5	0.0	.1	1.0	.1	4.0*
	Teacher	(t-1)	1.8	2.5*	1.3	5.2**	2.4	5.0**
	Tr X Te	(t-1)	1.0	.7	2.2	.4	.3	.7
	Pre X Te	(t-1)	1.2	1.8	3.2*	1.6	1.8	.4
	Tr X Pre X Te	(t-1)	1.4	1.8	2.1	1.5	1.4	1.0
	Error MS		.103	.186	.173	.156	.209	.380
	df		359	117	110	336	95	118
SMSG	Treatment	1	.2	0.0	0.0	3.5	0.0	0.0
	Premeasure	1	62.3***	52.7***	16.0***	18.4***	2.3	16.9**
	Tr X Pre	1	.2	.7	.1	1.9	1.4	.6
	Teacher	(t-1)	1.8	.7	1.4	3.8***	1.1	3.4**
	Tr X Te	(t-1)	1.0	.3	1.6	.6	.1	1.1
	Pre X Te	(t-1)	1.6	1.2	.7	1.5	1.8	1.3
	Tr X Pre X Te	(t-1)	1.2	2.9*	.6	1.1	1.1	2.0
	Error MS		.093	.158	.179	.166	.205	.307
	df		405	119	146	359	111	125

* p < .05, ** p < .01, *** p < .001

[a] t = number of teachers (i.e. pairs of classes) indicated in the table of means for each measure.

TABLE 9

Perceived Utility: Mean g - s Scores for Pupils in E and C Classes

All pupils 8 pairs E and C classes in each E program condition.

E Program	Treatment / Premeasure level	E low	E high	E ave.	C low	C high	C ave.
Ball State		4.21	5.21	4.71	4.58	5.49	5.04
UICSM		4.66	5.31	4.98	4.26	5.06	4.66
SMSG		4.13	5.06	4.60	4.50	5.17	4.83
Average all programs		4.33	5.19	4.76	4.45	5.24	4.84

Males 5 pairs E and C classes

E Program	Treatment / Premeasure level	E low	E high	E ave.	C low	C high	C ave.
Ball State		4.29	5.58	4.94	4.27	5.64	4.95
UICSM		4.97	5.55	5.26	4.73	5.13	4.93
SMSG		5.00	5.17	5.08	4.72	5.38	5.05
Average all programs		4.75	5.43	5.09	4.57	5.38	4.98

Females 6 pairs E and C classes

E Program	Treatment / Premeasure level	E low	E high	E ave.	C low	C high	C ave.
Ball State		3.78	4.72	4.25	4.12	4.94	4.53
UICSM		4.37	4.81	4.59	3.23	4.69	3.96
SMSG		3.75	4.51	4.13	3.60	4.71	4.15
Average all programs		3.96	4.68	4.32	3.65	4.78	4.21

In general these results indicate that pupils instructed with the Ball State materials had a tendency to perceive mathematics as having less utility than did pupils in conventional classes taught by the same teachers while pupils instructed with the UICSM materials perceived mathematics as having greater utility than did the pupils in the comparison conventional classes. This effect appeared to be stronger for girls than boys. Also for girls, the E - C difference for the UICSM program was more reliable than the E - C difference for the Ball State comparison.

Perceived Knowledge - The mean Perceived Knowledge index g - s scores for the E and C class pupils are shown in Table 10 . No significant treatment main effects or treatment interaction effects were indicated by the analysis of variance when all program comparison conditions were considered, as shown in Table 7 .

For the analysis within each E program condition, shown in Table 11, a reliable treatment difference was indicated for the SMSG comparison when all pupils and when males alone were considered. This effect was a result of the SMSG pupils obtaining lower Perceived Knowledge scores at the end of the year than conventional class pupils. The effect for all pupils combined appears to be due primarily to differences in this regard for boys rather than girls.

In general, the experimental programs do not appear to have any extensive effects on pupils' judgments of their knowledge of mathematics as measured by this index. However, there was a tendency for boys instructed with the SMSG program to judge their knowledge somewhat lower than did boys in the conventional comparison classes.

Ease of Learning - Table 12 shows the mean g - s scores obtained by E and C class pupils on the Ease of Learning (EOL) index. In each program comparison condition, the means for pupils in the C classes were in every instance higher than those for pupils in the respective E classes. That is, the C class pupils reported greater ease of learning (i.e., less difficulty learning) the subject matter in their mathematics class than E class pupils. The results of the analysis of variance, shown in Table 7 , indicated that the E - C difference over all program comparison conditions was quite reliable both when all pupils and when girls alone were considered. The analysis for boys alone did not indicate any significant overall instructional treatment differences suggesting that the effect observed with the sexes combined is due more to the differences in this regard for girls than for boys.

The results of an analysis within each of the programs for both sexes separately and combined are shown in Table 11 . Considering all pupils, the E - C difference was reliable at the .05 level only for the UICSM program comparison, while for girls a highly reliable difference was observed for the Ball State program comparison. No treatment differences were observed for boys for any of the comparisons.

TABLE 10

Perceived Knowledge: Mean g - s Scores for Pupils in E and C Classes

All pupils 8 pairs E and C classes in each E program condition.

E Program	Treatment Premeasure level	E low	E high	E ave.	C low	C high	C ave.
Ball State		8.09	10.47	9.28	8.72	10.46	9.59
UICSM		8.60	10.07	9.33	8.26	10.42	9.34
SMSG		7.56	10.12	8.84	8.10	10.42	9.26
Average all programs		8.08	10.22	9.15	8.36	10.43	9.39
Males 6 pairs E and C classes							
Ball State		8.49	10.00	9.25	7.98	10.37	9.18
UICSM		8.47	10.29	9.38	8.55	10.52	9.53
SMSG		7.90	10.69	9.30	8.95	11.17	10.06
Average all programs		8.29	10.33	9.31	8.49	10.69	9.59
Females 6 pairs E and C classes							
Ball State		8.05	10.50	9.28	8.80	10.50	9.65
UICSM		8.80	10.62	9.71	7.86	10.48	9.17
SMSG		7.74	9.89	8.81	7.90	10.02	8.96
Average all programs		8.19	10.34	9.26	8.18	10.33	9.26

TABLE 11

F-ratios From the Analysis of Variance Within Each of the E Program Comparison Conditions for Perceived Knowledge and Ease of Learning Index g - s Scores

E Program	Source of Variance	d.f.	Perceived Knowledge All Pupils	Perceived Knowledge M	Perceived Knowledge F	Ease of Learning All Pupils	Ease of Learning M	Ease of Learning F
Ball State	Treatment	1	1.0	0.0	1.1	3.1	.9	20.4***
	Premeasure	1	81.0***	23.3***	35.0***	56.7***	22.9***	14.0*
	Tr X Pre	1	.9	.5	1.1	1.2	2.5	0.0
	Teacher	(t-1)[a]	2.2*	1.0	1.1	1.4	1.1	1.2
	Tr X Te	(t-1)	1.7	2.4*	.6	.9	1.1	.8
	Pre X Te	(t-1)	.9	.4	.5	1.2	1.1	1.7
	Tr X Pre X Te	(t-1)	2.2*	2.5*	.9	1.0	.4	1.3
	Error MS		.419	.983	.741	.125	.267	.203
	df		304	107	118	306	110	94
UICSM	Treatment	1	0.0	.1	1.9	4.9*	.4	2.2
	Premeasure	1	48.9***	16.5***	32.5***	86.0***	23.0***	71.9***
	Tr X Pre	1	1.7	0.0	1.1	.2	0.0	.6
	Teacher	(t-1)	.9	.6	1.8	1.3	.5	1.5
	Tr X Te	(t-1)	.7	.7	.8	.5	1.9	.9
	Pre X Te	(t-1)	.4	.9	.3	1.0	.3	.4
	Tr X Pre X Te	(t-1)	.7	1.2	1.2	.4	.4	.2
	Error MS		.540	1.309	.911	.145	.316	.215
	df		320	122	102	305	119	89
SMSG	Treatment	1	3.9*	4.0*	.6	1.4	.1	1.6
	Premeasure	1	70.6***	17.9**	48.1***	65.2***	13.7*	21.5**
	Tr X Pre	1	.3	.6	0.0	.5	0.0	.5
	Teacher	(t-1)	5.1**	2.3*	5.0**	4.8***	.5	5.1***
	Tr X Te	(t-1)	.5	.3	1.6	1.7	.4	3.1 *
	Pre X Te	(t-1)	1.9	2.4*	1.0	1.8	2.0	1.9
	Tr X Pre X Te	(t-1)	1.1	.9	1.2	1.4	.5	1.8
	Error MS		.359	.878	.569	.099	.256	.187
	df		344	117	147	346	112	103

* $p < .05$, ** $p < .01$, *** $p < .001$

[a] t = number of teachers (i.e. pairs of classes) indicated in the table of means for each measure.

TABLE 12

Ease of Learning: Mean g - s Scores for Pupils in E and C Classes

All pupils 8 pairs E and C classes in each E program condition.

E Program	Treatment / Premeasure level	E low	E high	E ave.	C low	C high	C ave.
Ball State		2.57	3.66	3.12	2.93	3.74	3.34
UICSM		2.55	3.74	3.14	2.79	4.10	3.44
SMSG		2.49	3.60	3.04	2.57	3.86	3.21
Average all programs		2.54	3.66	3.10	2.76	3.90	3.33

Males 6 pairs E and C classes

E Program	Treatment / Premeasure level	E low	E high	E ave.	C low	C high	C ave.
Ball State		2.26	3.60	2.93	2.79	3.47	3.13
UICSM		2.70	3.84	3.27	2.94	3.99	3.46
SMSG		2.74	3.82	3.28	2.79	3.87	3.33
Average all programs		2.57	3.76	3.16	2.84	3.77	3.30

Females 5 pairs E and C classes

E Program	Treatment / Premeasure level	E low	E high	E ave.	C low	C high	C ave.
Ball State		2.63	3.60	3.12	3.53	4.52	4.03
UICSM		2.32	3.92	3.12	2.47	4.39	3.43
SMSG		2.68	3.75	3.21	2.93	4.35	3.64
Average all programs		2.54	3.76	3.15	2.98	4.42	3.70

In general, although the effect was not very large there was a consistent tendency for pupils instructed with each of the experimental programs to report more difficulty learning mathematics than pupils in the comparison conventional classes. This tendency was more evident for girls than boys and most pronounced for girls instructed with the Ball State program.

(b) Rank position scores

To obtain the r - p scores, since pupils differed as to both number and actual academic subjects other than mathematics in which they were enrolled, the mathematics ranks were determined for the combination of academic subjects which would permit inclusion of the largest number of pupils for comparison. Within the sample, among the possible 3, 4, and 5 subject combinations of mathematics, English, science, social studies and foreign language, the largest number of pupils were enrolled in a 3 subject combination of mathematics, English and science. Scores in terms of the rank position of mathematics relative to English and science were derived by summing the rank of the response for mathematics (1, 2 or 3) to each item in a given index. Individual scores for each index were then converted to standard scores having a mean of 50 and a standard deviation of 10 units.

The determination of mathematics rank position relative to two other specified subjects reduced somewhat the number of pupils that could be included in the analysis. Although the overall proportion reduced was relatively small for the r - p scores, this additional restriction did preclude carrying out a separate analyses for each sex when teachers were treated as a separate dimension because of the increased difficulty of obtaining sufficient frequencies in the separate cells required for the analysis. For these scores the sex differences were examined in connection with the analyses concerned with moderating factors presented below.

Table 13 shows the unweighted means obtained by E and C class pupils in the separate instructional treatment conditions on each of the indices for which r - p scores were determined. A summary of the results of the analysis of variance comparisons among these means considering all of the E programs for each indices are shown in Table 14 and of the comparisons within each E program condition in Table 15 .

Intrinsic Interest - No significant treatment main effects nor program by treatment interactions were observed for the r - p score index of intrinsic interest in the analysis across all E program conditions. The higher mean for the C class pupils in the Ball State comparison contributed to a significant treatment effect when the analysis was made within the separate program conditions shown in Table 15 .

Perceived Utility - For the index of perceived utility, the analysis considering all E programs (Table 14) indicated that the overall instructional treatment differences were not reliable, but that there was a significant program by treatment interaction. This resulted from the E class pupils instructed with the Ball State and SMSG programs having lower scores than those in the C

TABLE 13

Means for E and C Class Pupils on Indices Using Rank-Position Scores for each E Program Comparison Condition

Premeasure Level	E Program	E low	E high	E ave.	C low	C high	C ave.
Intrinsic Interest (8 pairs E & C Classes)[a]	BSP	44.4	49.7	47.1	46.3	52.8	49.5
	UICSM	47.6	53.4	50.5	46.8	52.2	49.5
	SMSG	46.2	55.0	50.6	47.0	55.7	51.3
	Ave. all programs	46.1	52.9	49.4	50.5	53.5	50.1
Perceived Utility (8 pairs E & C Classes)	BSP	45.6	50.4	48.0	48.1	52.4	50.2
	UICSM	48.2	54.0	51.1	44.3	53.4	48.8
	SMSG	45.7	53.0	49.3	48.9	56.9	52.9
	Ave. all programs	46.5	52.5	49.5	47.1	54.3	50.7
Perceived Knowledge (8 pairs E & C Classes)	BSP	43.5	52.7	48.1	47.6	54.7	51.2
	UICSM	48.4	51.6	50.0	45.3	53.9	49.6
	SMSG	44.2	53.1	48.7	45.5	52.9	49.2
	Ave. all programs	45.4	52.5	48.9	46.1	53.8	50.0
Ease of Learning (7 pairs E & C Classes)	BSP	43.7	51.5	47.6	48.9	54.7	51.8
	UICSM	45.7	52.3	49.0	45.5	55.1	50.3
	SMSG	43.1	50.6	46.8	46.0	54.0	50.0
	Ave. all programs	44.2	51.5	47.8	46.8	54.6	50.7

[a] Number of pairs of E and C classes in each E program comparison condition

TABLE 14

F-ratios From the Analysis of Variance Over All E Program Comparison Conditions for Each Attitude Index r - p Score

	Scales	Intrinsic Interest	Utility	Perceived Knowledge	Ease of Learning
	d.f.				
Program	2	2.0	2.8	.4	0.0
Treatment	1	1.5	2.0	3.0	11.5**
Premeasure	1	92.0***	125.7***	79.2***	99.4***
Program X Treatment	2	2.6	4.5*	2.8	1.0
Program X Premeasure	2	2.1	2.9	.8	.6
Treat. X Premeasure	1	0.0	1.0	.2	.2
Program X Treatment X Premeasure	2	.2	.9	3.3	.8
Teacher	3(t-1)	3.2***	1.5	1.9*	3.0***
Number of Teachers	t =	8	8	8	7
Teacher X Premeasure	3(t-1)	1.3	.8	1.9*	1.6*
Teacher X Treatment	3(t-1)	.9	2.0**	.9	2.5**
Teacher X Treatment X Premeasure	3(t-1)	.9	.8	1.2	1.3
Error MS		9.09	8.27	8.85	8.35
df		925	960	947	839

* $p < .05$, ** $p < .01$, *** $p < .001$

TABLE 15

F-ratios From the Analysis of Variance of Each Attitude Index r - p Score for Each E Program Comparison Condition

Program	Source of Variance	d.f.	Intrinsic Interest	Perceived Knowledge	Perceived Utility	Ease of Learning
Ball State	Treatment	1	5.0*	8.2**	2.0	8.0*
	Premeasure	1	27.9***	59.4***	19.4***	18.9**
	Teacher	(t-1)[a]	1.5	1.3	1.0	4.3
	Tr X Pre	1	.3	.5	.1	.9
	Tr X Te	(t-1)	1.0	.8	2.4*	2.1
	Pre X Te	(t-1)	1.0	.6	.5	2.4*
	Pre X Pre X Te	(t-1)	.8	2.1	.5	.6
	Error MS		9.80	8.94	8.72	7.26
	df		294	303	308	274
UICSM	Treatment	1	.8	.1	4.5*	1.0
	Premeasure	1	26.6***	26.1***	48.5***	52.0***
	Teacher	(t-1)	1.6	1.1	1.5	1.0
	Tr X Pre	1	0.0	5.8*	2.4	1.1
	Tr X Te	(t-1)	.4	.5	.9	1.4
	Pre X Te	(t-1)	.6	1.0	.7	1.2
	Tr X Pre X Te	(t-1)	1.0	1.0	.7	1.6
	Error MS		9.35	10.64	9.27	9.93
	df		307	306	311	312
SMSG	Treatment	1	.4	.2	4.8	1.8
	Premeasure	1	31.2***	15.8**	67.1	29.3***
	Teacher	(t-1)	7.1***	4.0***	2.0	8.3***
	Tr X Pre	1	0.0	.7	.1	.1
	Tr X Te	(t-1)	1.3	1.7	3.1**	6.0***
	Pre X Te	(t-1)	2.4*	4.7***	1.3	2.3*
	Tr X Pre X Te	(t-1)	.9	.4	1.4	1.4
	Error MS		8.15	7.22	6.99	7.24
	df		324	338	341	341

* $p < .05$, ** $p < .01$, *** $p < .001$

[a] t = number of teachers (i.e. pairs of classes) indicated in the table of means for each measure.

classes with which they were compared while the UICSM pupils had a higher mean score than those in their comparison classes. The results of the analyses within E program conditions (Table 15) indicated, however, that only for the UICSM program was the treatment effect significant. It appears that among the E programs, only the pupils instructed with the UICSM materials exhibited a greater tendency than those instructed with the conventional materials to develop a perception of mathematics as having relatively more utility than other subjects.

Perceived Knowledge - For the index of perceived knowledge neither the treatment main effect nor the program by treatment interaction reached the .05 level of significance in the analysis considering all program comparison conditions. Two significant treatment effects were observed in the analysis for the separate E programs. Pupils instructed with the Ball State program had reliably lower perceived knowledge scores than those in the comparison C classes. For the UICSM program a significant treatment by premeasure interaction was obtained. The latter resulted from the fact that among pupils at the lower level on the premeasure those in the UICSM classes had the higher mean while among pupils at the higher level on the premeasure, those in the C classes had a higher mean at the end of the year. A further test to determine if the mean differences within each premeasure level differed from zero showed that neither of these differences was highly reliable. For the lower premeasure level, $E > C$, $F = 3.8$, $.05 < p < .10$ and for the higher premeasure level, $C > E$, $F = 2.1$, $.10 < p < .25$. Nonetheless, the interaction indicates that there was a greater relative gain in perceived knowledge for UICSM instructed pupils who initially perceived their knowledge as relatively low than for those who had initially perceived their knowledge as relatively high.

These results in general indicate that at the end of the year pupils in the Ball State program tended more than those in the conventional program to perceive their knowledge of mathematics as being lower relative to their knowledge in other subjects. However, for pupils in the UICSM program, those that had lower perceived knowledge at the beginning of the year developed a perception of relatively greater knowledge in mathematics than did similar pupils in the C classes.

Ease of Learning - The analysis across all E program comparison conditions (Table 14) showed a highly reliable treatment difference with pupils in the C classes having a higher mean score as shown in Table 13. This indicates that over all program comparison conditions, C class pupils reported greater learning ease for mathematics relative to other subjects than did pupils in the E classes. Considering the separate programs, the E - C difference for the Ball State comparison was largest while that for the UICSM comparison was smallest. The analysis within each E program condition, shown in Table 15, revealed that the difference for the Ball State program was quite reliable, while the differences for the other program comparisons did not reach the .05 level of significance.

iii. Summary of results

Reviewing the results obtained from the analysis concerned with the effects of the experimental programs on the several specific dimensions of pupil attitude toward mathematics, there appeared to be some degree of similarity between the program differences indicated by the two types of index scores. For both the r - p and g - s scores, a consistently lower score on the Ease of Learning index was obtained for pupils instructed with the E programs, an effect which was most pronounced for the Ball State program.

For the index of Intrinsic Interest, when the r - p scores were used, the results indicated a reliable tendency for the Ball State pupils to develop lower intrinsic interest scores than did the conventional class pupils. A similar but nonreliable trend was also observed for this program when the g - s scores were used. No reliable E - C differences were obtained for either score on this scale for the UICSM and SMSG program comparisons.

On the Perceived Utility index, when either r - p or g - s scores were used, the direction of the E - C difference varied significantly between the UICSM program and the Ball State program. Both scores for UICSM instructed pupils were reliably higher than those for pupils in the comparison conventional classes. However, only for the g - s score was the difference which favored the C classes in the Ball State comparison statistically reliable when the direct comparison was made.

On the Perceived Knowledge index, there was some variation in significant differences indicated depending on whether the r - p or g - s scores were used. For the g - s scores, a treatment difference was observed only when the sexes were considered separately. The SMSG instructed boys had reliably lower g - s scores than those in the C classes. This was the only instructional treatment difference observed on these measures for the SMSG program comparison. When r - p scores were used, pupils in the Ball State program had lower scores than their C class counterparts. Also UICSM pupils having <u>lower premeasure</u> scores showed a higher perceived knowledge score at the end of the year than did similar C class pupils in contrast to the E - C difference for those having <u>higher premeasure</u> scores which favored the C class pupils.

It should be noted, however, that most of these differences were not very large, in most instances appearing to account for a considerably smaller proportion of the variance than the premeasure of each of the variables.

Considering the results of the analyses to determine the direct effects of the experimental programs on indices of both general and specific attitudes and interests in mathematics, several more general observations seem warranted. (1) The experimental programs appear to have a relatively small effect, either positive or negative, on the attitudes and interests pupils develop in the ninth grade at least as indicated by the most direct indices of these attitudes used in this study. (2) The Ball State program appeared to have a more negative than positive effect on the attitudes pupils develop toward mathematics when compared to conventional programs of instruction taught by the same teachers. This effect was most evident on the Perceived Knowledge and Ease of Learning indices. (3) The UICSM program was the only experimental program for which pupils exhibited a tendency to develop more positive attitudes toward mathematics than pupils in the comparison conventional classes and even for this program, these effects were quite limited. The largest effect for the UICSM program was on the Perceived Utility index. Pupils instructed with the UICSM program perceived mathematics as having greater utility for future goals and objectives than those instructed with conventional programs. (4) For all experimental programs, there was a consistent tendency for pupils instructed with the experimental materials to experience more learning difficulty than was reported by pupils in the conventional classes.

b. Program Differences on Attitude Relevant Instructional Factors and Conditions.

The above analyses were concerned primarily with the overall effects of the different experimental programs on pupil attitudes toward mathematics as such. Some differences in the resultant attitudes toward mathematics were observed. These differential outcomes were however necessarily determined or mediated by any of a number of more specific factors or conditions which must have differed among the alternate programs of instruction. Another question to be considered then concerns the factors or conditions in the instructional situation that on logical grounds appeared relevant to a change in attitude toward the subject matter and therefore might have contributed to or affected the program differences obtained. In the context of this question which was discussed above in more general terms, two main sets of factors or conditions were distinguished; those representing, respectively, direct and indirect effects of instruction with the alternate programs or materials. In these terms, the question assumes that these effects, as they were measured, occurred prior to any changes in the affective reactions assessed at the end of the year. Especially for those factors representing direct effects, this assumption appeared quite valid. Since they directly reflect or represent the major instructional differences, qualities or characteristics associated with the instructional materials themselves were the most obvious and likely source of any observed E - C attitude differences. Representing the second set of factors would be those associated with or determined by the teacher as such. Grading practices, instructional approach or methods, effort demands such as homework, expressed attitudes toward the materials, all are conditions which may have varied in a systematic way between the E - C classes and thereby contributed to or affected the observed differences. Data was gathered and comparisons were made with respect to both of these sets of factors.

i. Characteristics of instructional materials

Pupil judgments were obtained concerning various characteristics of the instructional materials. Several items inquired about how well the instructional materials facilitated learning while another involved the novelty of the material presented.[5] The item analysis indicated, however, that for only one of these items, that concerned directly with the ease or difficulty of the texts, item (a) below, was there any indication that the item was assessing factors not measured by other scales or items. Consequently, further analyses and consideration was given only to the judgments obtained for the item concerned directly with textbook difficulty.

Textbook difficulty. Judgments of textbook difficulty were of interest not only for the general reasons indicated above but also because the most distinctive E - C difference was obtained for a more general index of ease of learning which presumably reflected all sources of learning difficulty including that associated with the textbook as such. There were two questions to be considered with respect to pupil judgments concerning the instructional materials (1) whether the judgments varied for pupils in the E and C classes and (2) whether such judgment differences might have contributed to or affected any of the more general attitude differences observed between E and C class pupils.

The E - C differences in judgment of textbook difficulty were examined using the rank position response given by pupils to this item for mathematics relative to English and science. The greater the rank position value, i.e. 3, the relatively greater the difficulty. To make an appropriate comparison, it was necessary to take into account the pupils initial (beginning of year) judgment of learning ease or difficulty for mathematics materials to ensure that any obtained differences reflected the pupils experience during the year rather than his previous experience with mathematics materials. Since no textbook difficulty judgment was obtained at the beginning of the year the rank position score on the premeasure of the Ease of Learning (EOL) index was used for this purpose. Comparisons were made within each E program comparison condition for pupils above and below the EOL premeasure median for each of the sexes separately.

[5] These items read as follows:

a) How easy or difficult did you find it to understand the textbooks used in each of the subjects you have been taking?

b) How much has the textbook helped you to learn and understand the material in each of your subjects, in addition to the teacher's instruction?

c) Which helps you most to learn and understand the main ideas presented in each of your subjects, the teacher or the textbook?

d) To what extent did the material in each of the subjects you have taken seem repetitious and dull in contrast to novel and exciting?

For each item a five-point scale with appropriate labels defining the response dimension was provided.

To determine if the E - C frequency differences were statistically reliable in one or the other direction, a χ^2 test was used with the 1st and 2nd rank position frequencies combined.[6] To obtain at the same time an indication of the relative magnitude of the affects associated with initial or expected ease of learning (pre EOL) and with pupil sex as well as with the instructional treatment, a procedure outlined by Castellan (6) was followed which permitted determination of the relative contribution to an overall χ^2 by each of these factors. The results of this comparison are shown in Table 16 . The frequencies obtained within the categories for each of the three separate rank positions are shown in Appendix C .

For both the Ball State and SMSG programs, the E - C comparisons within each sex by pre EOL category showed a reliable ($p < .05$) difference in frequency (the value for $\chi^2{}_{abc}$) with a greater proportion of E class pupils in each instance having ranked their mathematics text as more difficult. For the UICSM program, none of the within category χ^2's ($\chi^2{}_{abc}$) were reliable at the .05 level although there was a tendency for E class pupils to more frequently rank their mathematics texts lower (i.e. as more difficult). No reliable sex differences ($\chi^2{}_{ab}$ with $p < .05$) in text difficulty judgments appeared for any of the programs, however for the Ball State comparison among pupils expecting more learning difficulty (low EOL), there was a greater tendency for boys to indicate more text difficulty than girls. With respect to levels of initial or expected learning ease (pre EOL), reliable differences ($\chi^2{}_a$) were observed for all programs. The latter differences indicate that pupils who expected more learning difficulty for mathematics in general (low EOL) more frequently reported greater text difficulty than those who did not (high EOL), which would be expected.

It is quite evident that pupils instructed with the Ball State and SMSG programs indicated much more frequently than pupils instructed with the respective conventional programs that their mathematics textbooks were more difficult than their English or science textbooks. For the UICSM pupils, there were no real differences in this regard although there also was no tendency for the UICSM pupils to judge their materials as less difficult.

[6] The two adjacent rank position categories could be combined and not alter the interpretation because the categories had an ordered relationship. Reducing to two response categories permitted an unambiguous interpretation of the direction of the significant difference between E and C classes.

TABLE 16

Text Difficulty Rank Frequency Comparisons Between E and C Conditions Considering Sex and Pre EOL Level

	t.d. rank	Male (b_1) E(c_1)	Male (b_1) C(c_2)	Male (b_1) Tot	Female (b_2) E(c_1)	Female (b_2) C(c_2)	Female (b_2) Tot	Total
Ball State								
Low Pre EOL (a_1)	1,2	2	13	15	20	21	41	56
	3	29	24	53	49	21	70	123
		31	37	68	69	42	111	179
		χ^2abc = 6.5*			χ^2abc = 4.1*			χ^2ab = 3.7
High Pre EOL (a_2)	1,2	22	47	69	13	30	43	112
	3	22	18	40	24	9	33	73
		44	65	109	37	39	76	185
		χ^2abc = 4.7*			χ^2abc = 11.9***			χ^2ab = .6
								χ^2a = 6.9**
UICSM								
Low Pre EOL (a_1)	1,2	11	11	22	7	18	25	47
	3	19	18	37	30	33	63	100
		30	29	59	37	51	88	147
		χ^2abc = 0.0			χ^2abc = 2.1			χ^2ab = .9
High Pre EOL (a_2)	1,2	26	29	55	16	18	34	89
	3	20	15	35	11	8	19	54
		46	44	90	27	26	53	143
		χ^2abc = .5			χ^2abc = .2			χ^2ab = 0.0
								χ^2a = 25.5***
SMSG								
Low Pre EOL (a_1)	1,2	6	19	25	8	24	32	57
	3	27	21	48	62	26	88	136
		33	40	73	70	50	120	193
		χ^2abc = 5.7*			χ^2abc = 18.1***			χ^2ab = .9
High Pre EOL (a_2)	1,2	15	38	53	13	34	47	100
	3	41	20	61	23	9	32	93
		56	58	114	36	43	70	193
		χ^2abc = 15.7***			χ^2abc = 13.3***			χ^2ab = 2.7
								χ^2a = 18.9***

* $p < .05$ χ^2abc = E - C comparison within sex x pre EOL categories

** $p < .01$ χ^2ab = Male - female comparison within pre EOL levels

*** $p < .001$ χ^2a = Pre EOL level comparisons

ii. Teacher determined conditions

Pupil grades. The grades pupils' receive in a subject would be expected to have some affect on their attitudes toward the subject matter. Within a given class, grades are no doubt quite highly related to independent measures of the pupil's relative proficiency or ability. It is possible however, independent of actual proficiencies, that teachers might have varied their grading standards between the separate classes they were instructing. Such variation would be more likely when teachers were using different programs of instruction in separate classes which, to the extent that the instructional objectives differ, might require judgments relative to different performance criteria. If this were the case in the present study, it could result in a difference in the distribution of grades assigned respectively to the E and C class pupils. There is a question then as to whether there was any systematic difference in the grades assigned to pupils in the E and C classes when previous mathematics class performance differences were held constant.

Information concerning the average or overall grade received in mathematics during the previous (8th grade) and concurrent year was obtained for pupils in a majority of classes participating in the study. To determine if there were any grade differences between E and C class pupils, comparisons were made within each E program comparison condition using the three factor analysis of variance. The analysis was restricted to class pairs for which grade data was available which reduced the number that could be included in each program comparison. Table 17 shows the adjusted grade means for pupils instructed with the alternate programs and Table 18 shows the results of the analyses of variance for this measure. The analyses provided no indication that there were any overall differences in the grades received by pupils in the E and C classes for each E program comparison condition. It does not appear then that any instructional treatment differences observed with respect to pupil attitudes could be attributable to general or systematic differences between the grades received by E and C class pupils.

A moderately reliable teacher by treatment interaction was observed for both the Ball State and UICSM program comparisons. This result indicates some variation in the magnitude and/or direction of the E - C grade differences between teachers.

TABLE 17

Adjusted Grade Means for E and C Class Pupils in Each E Program Comparison Condition

E program	Number of class pairs	Premeasure level	Treatment E low	E high	E ave.	C low	C high	C ave.
Ball State	8		3.14	5.36	4.25	3.28	5.15	4.22
UICSM	5		3.02	5.42	4.22	3.75	5.74	4.74
SMSG	8		3.96	5.48	4.72	3.45	5.48	4.46

Values assigned letter grades:

A = 1 B = 3 C = 5 D = 7 F = 9
A-, B+ = 2 B-, C+ = 4 C-, D+ = 6 D- = 8

TABLE 18

F-ratios from the analysis of variance for pupil grades in each program comparison condition.

Source of Variance	d.f.	B.S.	UICSM	SMSG
Treatment	1	0.0	1.4	2.3
Premeasure	1	119.1***	21.0*	52.7***
Teacher	$(t - 1)^a$	6.4***	17.6***	6.2***
Tr X Premeasure	1	.9	.7	2.2
Tr X Teacher	(t - 1)	2.5*	3.0*	1.2
Pre X Teacher	(t - 1)	.6	3.7**	2.0*
Tr X Pre X Teacher	(t - 1)	.9	.2	.5

[a] t = number of class pairs for each program condition indicated in Table .

* $p < .05$, ** $p < .01$, *** $p < .001$

Teacher attitudes and judgments concerning the E programs. Another instructional factor or condition which could have differentially affected the attitudes of pupils in a pair of E and C classes was the judgment or attitude of the teacher concerning the materials being used. A characterization of the materials by the teacher to the pupils, either in general evaluative terms or in terms of their anticipated instructional outcomes or purposes could affect the pupils reaction either to the materials or to the subject matter itself. Such a characterization would be especially likely in the E classes because the materials were obviously different. As part of the more extensive project concerned with the effects of the E programs on pupil achievement in mathematics, a questionnaire had been prepared to elicit participant teacher judgments and reaction to the experimental instructional materials they were using. From the questionnaire items, several scales were derived. The questionnaire provided indices of (1) the teacher judgment of the relative extent to which the E and C programs achieved certain instructional objectives. (2) The teachers preference for E relative to C materials and (3) the teachers judgment of the pupils reaction (in general evaluative terms) to the materials and the subject matter.

To examine this question, a single index representing the E - C class mean difference (adjusted for premeasure differences) on each of the attitude scales for each individual teacher was obtained. The degree of association between the teachers adjusted E - C class mean difference score for each attitude index and teachers score on each of the teacher judgment indices was determined. Classifying teachers either above or below the median on each pair of indices, the degree of association was determined by the Fisher exact probability test. The results indicated that none of the teacher judgment indices were reliably related to the instructional treatment (E - C) differences obtained for individual teachers for any of the attitude indices. There was no evidence then that the teacher attitudes or judgments as measured by the teacher questionnaire indices were related to or affected the differences in attitude observed between the E and C classes.

iii. Summary and Discussion

Among the variables that were examined which on logical grounds appeared likely to have mediated, in the sense of contributing to or affecting, the program differences in attitudes, only for the text difficulty judgment were any program differences observed. If the difficulty pupils experienced with their instructional materials affected their attitudes toward the subject matter, the text difficulty differences observed for the Ball State and SMSG instructed pupils could have been a factor contributing to the development of more negative attitudes toward mathematics. From the attitude indices, there were some indications that the Ball State instructed pupils had developed less positive attitudes than those in conventional programs, although a similar tendency was not found for the SMSG pupils. It is likely, however, that text difficulty was only one of a number of independent factors that might have affected pupils' attitudes with the outcomes reflected on the attitude indices representing a resultant effect of various factors and conditions including those specific to the alternate programs of instruction. The fact that the SMSG program, in contrast to the Ball State program, did not show evidence of the development of less positive attitudes even though there was an equally strong text difficulty difference, suggests that for the SMSG program other factors may have been countering any negative effects that might have resulted from a higher level of text difficulty.

There is then the question of the extent to which text difficulty contributed to or affected attitude change within each of the programs and thereby, to the differential attitude changes observed for the separate experimental programs compared. There is also a related question of the attitude differences that would be expected for the experimental programs independent of the text difficulty effects, i.e., the attitude change resulting from qualities ard characteristics as well as other concommitant conditions associated with the experimental programs. There is further the question of the extent to which text difficulty affected pupil attitudes, in general, independent of the specific instructional program conditions. All of these are part of a broader question in connection with which a distinction can be made between those effects of text difficulty that are associated with the specific instructional materials, representing program differences; those effects associated with the teacher, representing teacher differences, and those associated with and representing individual pupil differences. These are conceptually independent effects in that it is possible that the relations between text difficulty and attitude change that existed <u>within</u> classes or <u>within</u> program conditions could have differed from those that existed <u>between</u> classes and/or conditions.

Although it was not possible within this study to obtain a direct and unequivocal answer to all of these questions, analyses were carried out that could provide some indication of the nature and extent of the relationships involved.[7] The question of the effects of text difficulty on pupil attitudes in general concerns the degree to which change in attitude corresponds to level of text difficulty when the latter is adjusted for initial differences in expected difficulty, that is the correlation between post measures of text difficulty and attitude when premeasures of those variables were held constant. This question was answered by determining the second-order partial correlations between

[7] The appropriate procedure for determining the attitude differences between programs controlling for the program effects on text difficulty in addition to the text difficulty effects within programs would require determining the specific or unique within cell contribution of text difficulty to attitude change independent of the effects of other factors correlated with these variables. The latter factors would tend to inflate the relation between text difficulty and attitude change which would be the basis for the between treatment adjustment and since they would not represent treatment effects should not contribute to that adjustment.

text difficulty and post measures of several of the attitude indices with the premeasure of expected difficulty and of the attitude measure being partialled out. The zero and second-order correlations obtained between the attitude and text difficulty measures for the entire sample of pupils included from all instructional program conditions are shown in Table 19 .

TABLE 19

Zero and Second-order Correlations Between
Pre and Post Measures of Attitude and Text Difficulty

(N = 575)

Index	Aiken Scale		Intrinsic Interest		Perceived Utility		Perceived Knowledge	
	(3)	(4)	(3)	(4)	(3)	(4)	(3)	(4)
Variable	pre	post	pre	post	pre	post	pre	post
(1) Post attitude	69	-	47	-	39	-	44	-
(2) Text difficulty	-46	-29	-47	-28	-31	17	53	-30
(4) Pre EOL	32	44	34	52	24	36	41	72

$r_{24} = - 37$

	Aiken Scale	Intrinsic Interest	Perceived Utility	Perceived Knowledge
$r_{12.34}$	-40	-39	-25	-45

(Decimal points were omitted from figures)

For all measures except the Aiken scale, rank-position scores were used.

For each of the attitude indices, the second-order partial correlation ($r_{12.34}$) was reliably greater than zero with $p < .001$. These results indicate that there was a clear nonchance relationship between the degree of text difficulty experienced during the year and the amount of attitude change. As suggested above, these results, however, do not necessarily indicate that the text difficulty differences between programs accounted for, i.e., were responsible for, the attitude differences. The partial correlations obtained above reflect both the within and between program condition relations that existed between text difficulty and attitude change. It is conceivable that the correlations reflected relationships that existed primarily within rather than between the program conditions. Another possibility is that the relations between text difficulty and attitude change, either within and/or between conditions, reflected the effects of a third variable related to both, such as grade change. Evidence supporting either of the latter possibilities is provided by an examination of the treatment effects observed for grade change and the relations between grade change and attitude change. No instructional program differences were indicated for grades pupils received in ninth grade algebra, nonetheless the second-order partial correlation (considering all pupils) between post grades and attitudes (controlling for premeasures of each) indicate that these relationships were highly significant. For example, the second-order correlation between post Aiken scale scores and grades was .27 ($p < .001$). Since there were no significant between condition differences for grade change, this relationship must be primarily the result of the relations existing within the treatment conditions relations. Also, this relationship is of sufficient magnitude to suggest that grade change could be the main source of attitude change rather than text difficulty. A detailed analysis to determine more exactly the nature of the relations among text difficulty, grade change and attitude change, as well as the instructional program effects when these relations are considered, was carried out in conjunction with the second year study reported below.

c. Program Effects Considering Possible Moderator Variables

Another question separate from that concerning the general effects observed for the E programs was whether the effects on attitudes and interests were the same for all pupils or the same under all conditions of instruction. This is a question of whether certain pupil characteristics or instructional conditions functioned as moderator variables, in the sense that they interacted with the instructional program variations to alter or modify their effects. On the basis of more general considerations, somewhat different attitude and interest effects could have varied with such pupil characteristics as sex or level of mathematics ability or with the amount of experience teacher's had using their respective E programs. Analyses were carried out considering each of these factors as a possible source of differential attitudinal effects for the separate instructional programs.

i. Pupil characteristics

In the previous analyses sex differences in attitudes toward mathematics as they developed over the year were observed in several instances. On the Perceived Utility index a consistently higher score was obtained by boys which was however independent of the various instructional program differences and no doubt reflected the effects of factors other than the instructional materials. Although the instructional treatment effects tended to be in the same direction for both sexes, larger and more reliable differences were observed more frequently for girls in the analyses using the g - s scores on the Intrinsic Interest, Utility and Ease of Learning indices. Another indication of pupil sex as a moderator variable was observed on the Aiken scale for the UICSM comparison. This appeared in the initial analysis for the Aiken scale for which a reliable treatment by premeasure effect was observed for girls but not for boys.

With respect to mathematics ability or proficiency as a possible moderating variable, the question is whether the E programs affected the attitudes of pupils having relatively higher and lower proficiency in any differential way. This question derives from logical as well as empirical considerations. In a separate questionnaire, distributed to obtain their reactions to the experimental programs they were teaching and judgments of their pupil's reaction to these materials, teachers were asked to indicate, for high, average, and low ability pupils separately, whether those in the E or C classes responded more favorably to their respective materials. A high porportion of the responding teachers indicated that among higher ability pupils, the response was more favorable for those in the experimental class, while among low ability pupils the response was more favorable for those in the C classes. (See Ryan and Rising (13)). This judgment probably represents a belief that the somewhat greater emphasis on the conceptual aspects of mathematics in the E programs would have relatively less appeal to lower ability pupils, while the somewhat more rote computational and rule learning character of the conventional programs would have relatively less appeal to the higher ability pupils. If true, then an interaction between ability and instructional program should have occurred on measures of interest such that among lower ability pupils those in the E classes had less interest at the end of the year than those in the C classes, while among higher ability pupils, those in the E classes had the greater interest.

To examine these questions, comparisons were made considering pupil sex and initial proficiency in mathematics for each of several attitude and interest indices; the Aiken scale, and the indices of Intrinsic Interest and Perceived Utility using the r - p scores for the latter. The pupils score on the mathematics section of the STEP obtained at the beginning of the year served as a measure of mathematics ability or proficiency. The comparisons were made using analysis of variance within each E program condition. Four factors were considered; instructional treatment (E or C), pupil sex, and initial (pre) levels of proficiency and of interest, the latter being the premeasure of the dependent variable. For each of the latter two measures, two levels determined by the median of the distribution of scores of all pupils on each were used.

In this analysis, variation of the treatment effects with the pupils' initial level of proficiency, sex and/or both factors would be indicated by significant treatment by proficiency, treatment by sex, or treatment by proficiency by sex interactions, respectively. Table 20 shows the adjusted means on each of the attitude indices for pupils having higher and lower levels of proficiency within sex, instructional treatment, and E comparison condition categories. Tables 21 and 22 show the results of the analyses of variance for each of the indices.

As can be seen, for none of the interest measures were the specific lower order interactions indicating a general moderating effect for

TABLE 20

Adjusted Interest Index Means for E and C Class Pupils by Sex and Level of Proficiency in Mathematics for Each Program Comparison Condition.

Ball State	Math Proficiency Level	Aiken E	Aiken C	Intrinsic Interest E	Intrinsic Interest C	Perceived Utility E	Perceived Utility C
Sex	low	3.13	3.23	46.4	49.4	47.4	52.1
M	high	3.58	3.59	49.2	51.7	51.3	53.5
	ave.	3.35	3.41	47.8	50.6	49.3	52.8
	low	3.02	3.37	46.1	48.0	48.1	48.3
F	high	3.53	3.66	49.0	51.8	47.0	51.0
	ave.	3.27	3.51	47.6	49.9	47.5	49.7
	low	3.08	3.30	46.2	48.7	47.7	50.2
All	high	3.55	3.62	49.1	51.8	49.1	52.3
	ave.	3.31	3.46	47.7	50.2	48.4	51.2
UICSM							
	low	3.10	3.23	48.7	49.4	51.7	49.1
M	high	3.45	3.64	52.4	51.5	53.2	53.2
	ave.	3.27	3.43	50.5	50.4	52.4	51.1
	low	3.36	3.16	48.2	49.0	49.4	45.4
F	high	3.51	3.52	52.1	50.7	50.8	50.9
	ave.	3.44	3.34	50.1	49.9	50.1	48.1
	low	3.23	3.19	48.4	49.2	50.5	47.2
All	high	3.48	3.58	52.2	51.1	52.0	52.1
	ave.	3.35	3.39	50.3	50.1	51.3	49.6
SMSG							
	low	3.10	3.43	48.4	51.0	50.2	52.5
M	high	3.52	3.40	54.3	54.5	52.5	53.4
	ave.	3.30	3.41	51.4	52.7	51.3	52.9
	low	3.11	3.31	49.2	51.2	47.3	52.6
F	high	3.23	3.44	51.9	48.6	50.1	50.3
	ave.	3.17	3.37	50.6	49.9	48.7	51.4
	low	3.12	3.37	48.8	51.5	48.7	52.5
All	high	3.37	3.42	53.1	51.6	51.3	51.8
	ave.	3.24	3.39	50.9	51.3	50.0	52.2

TABLE 21

Results of analysis of variance of Aiken scale and Intrinsic Interest index (r-p) scores within each experimental program condition considering pupil sex and proficiency in mathematics.

		Aiken						Intrinsic Interest					
		Ball State		UICSM		SMSG		Ball State		UICSM		SMSG	
Source of Variation	d.f.	Mean square	F	Mean square	F	Mean square	F	Mean square	F	Mean square	F	Mean square	F
Treatment	1	.0877	3.4	.0042	.2	.0979	4.6*	26.4	6.8**	.1	.0	.5	.1
Sex	1	.0004	.0	.0050	.2	.0306	1.5	.8	.2	1.0	.2	13.4	3.3
Math Proficiency	1	.6385	24.5***	.4029	14.9***	.0947	4.5*	34.9	9.0**	31.9	7.3**	22.3	5.4*
Premeasure	1	2.4120	92.4***	3.1732	117.4***	4.0574	192.0***	148.9	38.3***	129.6	29.7***	272.9	66.5***
T X S	1	.0333	1.3	.0652	2.4	.0087	.4	.2	.1	.0	.0	4.2	1.0
T X MP	1	.0240	.9	.0175	.7	.0479	2.3	.0	.0	3.9	.9	14.1	3.5
T X P	1	.0022	.1	.0040	.2	.0014	.1	5.1	1.3	.8	.2	.1	.0
T X S X MP	1	.0049	.2	.0062	.2	.0515	2.4	.6	.2	.1	.0	2.0	.5
T X S X P	1	.0190	.7	.0000	.0	.0187	.9	.5	.1	.2	.1	1.3	.3
T X MP X P	1	.0029	.1	.1263	4.7*	.0277	1.3	1.9	.5	4.9	1.1	1.6	.4
T X S X MP X P	1	.1048	4.0*	.0012	.0	.0011	.1	11.9	3.1	7.4	1.7	1.2	.3
Residual [a]	4	.0442	1.7	.0261	1.0	.0257	.3	4.8	1.9	5.6	1.3	7.3	1.8
Adjusted error	d.f.	341		267		392		342		317		340	
	M.S.	.0260		.0270		.0211		3.9		4.4		4.1	

[a] Includes the remaining first and second order interactions that do not involve the treatment factor.

TABLE 22

Results of Analysis of Variance of Perceived Utility Index (r-p) Scores Within Each Experimental Program Condition Considering Pupil Sex and Proficiency in Mathematics

Source of Variation	d.f.	Ball State Mean square	Ball State F	UICSM Mean square	UICSM F	SMSG Mean square	SMSG F
Treatment	1	31.6	8.4**	10.8	2.3	18.5	6.3*
Sex	1	24.4	6.5*	28.4	6.0*	16.9	5.7*
Math Proficiency	1	11.7	3.1	39.3	8.2**	3.4	1.2
Premeasure	1	60.7	16.1***	159.0	33.3***	305.9	103.3***
T x S	1	1.9	.5	.5	.1	1.4	.5
T x MP	1	.4	.1	11.0	2.3	10.5	3.5
T x P	1	.3	.1	6.9	1.5	.3	.1
T x S x MP	1	10.5	2.8	.7	.2	3.4	1.1
T x S x P	1	5.1	1.4	9.8	2.1	3.3	1.1
T x MP x P	1	4.3	1.2	.1	.0	1.6	.6
T x S x MP x P	1	1.5	.4	3.6	.8	.0	.0
Residual	4	4.1	1.1	1.9	.4	2.5	.8
Adjusted error	d.f.	396		321		399	
	M.S.	3.8		4.8		3.0	

* p < .05 ** p < .01 *** p < .001

for pupil proficiency and/or sex, significant at the .05 level or less. For the Aiken scale, two higher order interactions were indicated; a treatment by proficiency by premeasure interaction for the UICSM program comparison and an interaction involving all four factors for the Ball State program. Neither of these interactions appeared to reflect an easily interpretable pattern of effects[8] and since the analysis was concerned primarily with more general, i.e. lower order, interaction effects no further comparisons were carried out.

In general, on the basis of this analysis, it does not appear that the effects of the experimental programs vary between pupils having different levels of proficiency in mathematics at the beginning of the year, i.e., mathematics proficiency did not moderate attitude differences between instructional programs. Nor did this analysis provide any conclusive evidence that there were any differential treatment effects associated with sex differences.

The analyses considering initial pupil ability and sex, however, revealed other differences which had more general implications concerning the instructional treatment effects. It can be seen in Table 21 for the SMSG program comparison on the Aiken scale that a reliable treatment difference was indicated which resulted from higher mean scores obtained by pupils instructed with the conventional rather than the SMSG program. This difference had not been found to be as large nor as reliable in the previous analysis (shown in Tables 3 and 5). Moreover, a change of some degree in the magnitude and reliability of the instructional treatment differences for the E programs was also indicated for the index of Perceived Utility. For the latter analysis, reliable E - C differences were indicated in the Ball State and SMSG comparisons with the C class pupils having the higher mean scores in both instances. In the previous analysis (shown in Table 15) however, although these differences were in the same direction, they were not statistically reliable. For the UICSM program in the analysis considering pupil proficiency and sex, the E - C difference was smaller and less reliable (actually non-significant by the criterion being used) than had appeared in the previous analysis.

The difference in outcome between the two analyses could have been due to either or both of two conditions: (1) A variation in the E - C differences for individual teachers for whom there was also a concommitant variation in class size. The earlier analysis adjusted for

[8] For the UICSM program, in terms of E - C differences the interaction reflected a difference in favor of the E class pupils for those low on premeasures of both ability and interest or high on both premeasures while the difference favored C class pupils in the remaining two cross classification categories.

class size differences (by considering "teacher" as a dimension)[9] while that involving pupil ability and sex did not include this adjustment. However, if between teacher variations in E - C differences were of some magnitude, this should have been reflected by a reliable teacher by treatment interaction. (2) A difference between E and C class pupils with respect to the distribution of one or both of the factors (proficiency and/or sex) for which there was some degree of correspondence with the dependent variable that had not been adjusted out by the premeasure control variable. The procedures followed for the analysis were directed toward minimizing E - C differences with respect to the premeasure for a given index. These procedures should also have reduced or minimized E - C differences with respect to any other beginning-of-year pupil characteristics which happened to be correlated with the dependent variable assuming that they would be at least as highly correlated with the premeasure of the dependent variable. It may have been that the analysis procedures did not provide a sufficient control or adjustment for the effects of certain pupil characteristics such as sex or initial proficiency on at least some of the indices and/or these characteristics were more highly related to the post than the premeasures of the variable.

It was on the perceived utility index that the alternate analyses differed most with respect to the statistical significance (but not direction) of the differences for the separate E programs. On this index for the UICSM comparison, both proficiency and sex were related to the dependent variable as indicated by the main effects for each, while no teacher by treatment interaction was indicated in the earlier analysis. Also a closer examination of the data revealed a slightly higher overall proportion of both males and higher proficiency pupils (members of both categories tending to have higher scores) in the UICSM classes. The latter differences, which may not have been adjusted out of the earlier analysis, appear to provide the most plausible explanation for differences obtained by the separate analyses for the UICSM program comparison. For the SMSG and Ball State comparisons, reliable teacher by treatment interactions as well as sex differences were obtained in the separate analyses. For each of these comparisons, the distribution with respect to initial proficiency was quite similar for E and C groups but for the Ball State comparison there was a higher proportion of males in the C classes. Consequently for these programs either of the above conditions could have contributed to the variation in results.

[9] Giving equal weight to the scores obtained for each class unit is essentially an adjustment for variations in the number of pupils in the class units.

The occurrence of an overall difference in the sex and proficiency distributions however does not unequivocally indicate that these factors were accounting for the variation in treatment effects indicated by the analyses since the analysis design could have controlled for some variation in these factors. A more extensive analysis providing for direct control on the possible effects of each of these factors would be required to determine the nature of the E - C differences in more precise terms.

For the most part the results observed with respect to the treatment differences when pupil sex and proficiency were taken into account affect primarily the conclusions that could be made for the UICSM program on the perceived utility index. It appears that the reliably higher score indicated for UICSM instructed pupils in the previous analysis may have been due in part to factors other than the instructional program. On the other hand, for an analysis on perceived utility scores across all E program conditions, a reliable treatment by program interaction ($F(2,1116) = 6.1$, $p < .01$) was again obtained when pupil sex and proficiency were considered. The latter interaction reflected the variation in the direction of the E - C differences between the UICSM and the other E program comparison conditions which had been observed in the previous analysis shown in Table 14 indicating that there was not as much negative change in the perception of mathematics utility for the UICSM as for the Ball State and SMSG pupils.

ii. Teacher experience with the experimental programs

It would be reasonable to expect that as teachers had additional years experience with a new program of instruction, they would be in a better position to impliment the instructional objectives specific to that program and probably reduce somewhat any special difficulties or additional effort required in connection with its use. To the extent that such factors affected pupil attitudes either directly or indirectly, they would contribute in general to greater variation in E - C differences among teachers having differing amounts of experience and specifically to greater differences in favor of the E program for classes of teachers with more experience. On the other hand, over time there might be a tendency, due in part to increased familiarity, for the teacher to introduce some of the more positive characteristics of the E programs in his conventional classes. If this were the case smaller E - C differences in pupil outcomes affected by these factors would be expected. A question exists therefore, as to whether E - C differences for the measures obtained did vary between teachers having more or less experience with the respective E programs they were using.

In the earlier analyses for each of the attitude indices, teachers were treated as a separate dimension. Consequently if any teacher connected characteristics contributed to a reliable variation in the treatment differences, this effect would necessarily have been reflected in the analyses by a significant teacher by treatment or teacher by treatment by premeasure interaction. Conversely, nonsignificant teacher by treatment interactions would indicate that there were no real variations between teachers with respect to E - C differences on the measure being considered.

Examining the results of the analysis carried out for the separate attitude measures, only for the following measures and E program comparison conditions were significant teacher by treatment interactions indicated: Perceived Knowledge, g - s score, Ball State; Perceived Utility, r - p score, Ball State and SMSG; and Ease of Learning, r - p score, SMSG.[10] For each of these measures and E program conditions, additional analyses were carried out to determine if the between teacher variation in E - C differences resulted from or was associated with differences in teacher experience with the E programs. In each instance teachers were classified according to their relative level of experience and the reliability of the E - C treatment difference within each experience level was determined using analysis of variance within each experience level. The adjusted means being compared and the pertinent results of the analysis are shown in Table 23 .

For the Ball State and UICSM programs on the Perceived Utility index (r - p scores) and the Ball State program on the Perceived Knowledge index (g - s scores), none of the within experience-level treatment differences reached the .05 level of significance. It is evident though that in each of these instances the classes of the most experienced teachers tended to exhibit the smallest E - C differences. The within experience-level comparison for the SMSG program on the EOL index (r - p scores) did however show a highly reliable treatment difference for classes of teachers having the most experience with this program. The latter result indicates that the tendency observed more generally , which was for E class pupils to experience greater learning difficulty, occurred for SMSG instructed pupils in classes of teachers having the <u>most</u> experience with this program. On logical grounds it would seem that a difference of this type would be more likely among classes of teachers having less experience with a specific program.

In general the treatment differences did not vary with the amount of teacher experience with the E programs. For the SMSG program reliably greater ease-of-learning scores were obtained by C class pupils' of teachers having somewhat more experience. No such difference was indicated for teachers having less experience.

d. <u>Properties of and Relations Among the Attitude, Interest and Proficiency Measures</u>

Because it is relevant to some of the methodological questions discussed above, certain properties or characteristics of the measuring instruments that were used should be considered. The properties of primary interest are the reliability and validity of these measures.

[10] For the Ball State program on the Perceived Knowledge score, a significant three-way (teacher x treatment x premeasure) interaction was indicated.

TABLE 23

Results of Analysis of Variance Within Levels of Teacher Experience With E Program

Index	E Program	Years Experience	No. of Teachers	Treatment Adjusted Means		Difference	Treatment		Error		F Ratio
				E	C	E - C	M.S.	d.f.	M.S.	d.f.	
Perceived Utility	Ball State	1,2	3	47.1	51.0	-3.9	45.5	1	24.3	2	1.9
		3.	5	48.5	49.8	-1.3	8.6	1	20.5	4	.4
Perceived Utility	SMSG	1	5	49.2	54.0	-4.8	112.4	1	30.5	4	3.7
		2,3	3	49.6	51.2	-1.6	7.8	1	6.6	141	1.2
Ease of Learning	SMSG	1	5	47.1	49.3	-2.2	24.5	1	71.6	4	.3
		2,3	3	46.4	51.1	-4.7	66.4	1	6.6	141	10.0***
Perceived Knowledge	Ball State										
	low premeasure	1,2	5	8.1	9.2	-1.1	3.33	1	.96	4	3.5
		3	3	8.1	7.9	.2	.09	1	1.92	2	.1
	high premeasure	1,2	5	10.6	10.4	.2					
		3	3	10.3	10.6	-.3					

A preliminary test indicated no reliable variation in E - C differences between teacher experience levels, therefore no within level tests were run.

In the context of the objectives of this study, the question of validity concerns the degree to which the separate attitude and interest indices are measuring relatively independent or separate attitudinal reactions or dimensions and whether on the whole the affective factors or reactions being measured are independent of performance or achievement characteristics and more general academic attitudes.

Reliability. Data were gathered and analyses carried out to obtain estimates of both the internal consistency and the stability of the scores for the various indices or measures that were used. To obtain an estimate of the reliability of the various attitude indices over time, the fall version of the questionnaire containing all items in the indices was administered twice within a three month interval to a sample of 200 ninth grade algebra pupils in three schools not participating in the main study. Produce-moment correlations were computed for both absolute-value and rank-position scores on the indices derived from the questionnaire responses. The test-retest reliability coefficients for the "retest" sample are shown in Table 25 . (A separate indication of the stability of the indices over the school year was obtained for the main data sample from the correlations between scores on the same indices obtained from the Fall and Spring questionnaires. These are shown in Table 26).

Internal consistency reliability coefficients[11] were computed separately for the indices from the first and second administration of the questionnaire (fall version) to the retest sample shown in Table 25 and for the indices derived from the fall and spring versions of the questionnaire for the actual data sample shown in Table 24 . These coefficients were computed for both absolute value and rank position scores. The reliability coefficients indicate that each of the separate indices was sufficiently internally consistent to provide an adequate measure of a pupil characteristic for purposes of group comparison.

Relations between indices. Tables 26 and 27 show the correlations obtained between the separate attitude and interest indices and measures of achievement for the graphic-scale and rank position scores, respectively.

[11] These were determined using the Hoyt reliability formulas found in Cronbach, Rajaratnam and Gleser (7). This procedure utilizes analysis of variance considering the within pupil item response variance and the between pupil score variance.

The Hoyt formula is:

$$r_{11} = \frac{\text{MS between pupils} - \text{MS within pupils}}{\text{MS between pupils}}$$

TABLE 24

Coefficients of Internal Consistency Obtained for the Attitude and Interest Measures from the Data Sample (N = 1100)

Measure	Fall		Spring	
	a-v	r-p	a-v	r-p
Aiken scale	a	-	96	-
Intrinsic Interest	78	80	81	86
Perceived Utility	77	75	83	75
Perceived Knowledge	72	76	78	86
Ease of Learning	73	71	89	87

[a] Computed only for spring administration

TABLE 25

Reliability Coefficients Obtained for the Attitude and Interest Indices from the "Retest" Sample

Measure	Test-retest		Internal Consistency			
			First Admin.		Second Admin.	
	a-v	r-p	a-v	r-p	a-v	r-p
Aiken scale	81	-	a	-	a	-
Dutton scale	64	-	b	-	b	-
Intrinsic Interest	70	60	80	83	82	86
Perceived Utility	54	50	72	76	84	81
Perceived Knowledge	61	65	79	91	82	90
Ease of Learning	68	61	76	71	75	86

[a] An internal consistency coefficient for the Aiken scale was determined for the data sample only since this scale had been originally developed independent of the present data sample.

[b] Because of the nature of the response required for the separate items on this Likert type scale, it was not appropriate to compute the coefficient used for the other scales. No alternative procedure for computing the internal consistency for this scale was determined.

TABLE 26

Correlations Between Graphic-scale Scores Obtained on Attitude and Interest Indices and Measures of Achievement*

Measure	1	2	3	4	5	6	7	8	9
1 Intrinsic Interest	**55**	54	70	67	54	59	36	36	22
2 Perceived Utility	42	**42**	51	49	43	43	30	28	29
3 Aiken scale	67	39	**69**	85	68	70	48	48	34
4 Dutton scale	60	38	82	**65**	61	63	44	42	32
5 Perceived Knowledge	41	33	57	52	**59**	72	57	68	45
6 Ease of Learning	47	29	58	51	62	**57**	56	58	39
7 Expected Grades	41	28	51	46	63	56	**45**	68	39
8 Actual Grades	17	14	28	25	45	31	50	**65**	49
9 STEP-Math	07	15	23	22	38	27	38	43	**61**

TABLE 27

Correlations Between Rank-position Scores Obtained on Attitude and Interest Indices and Measures of Achievement*

Measure	1	2	3	4	5	6	7	8	9
1 Intrinsic Interest	**47**	56	59	57	69	60	53	32	19
2 Perceived Utility	50	**39**	36	36	43	35	33	10	13
3 (Aiken scale)	47	24	**69**	85	56	52	47	48	34
4 (Dutton scale)	45	25	82	**65**	56	50	44	42	32
5 Perceived Knowledge	67	38	45	43	**44**	78	66	43	19
6 Ease of Learning	47	34	44	42	67	**45**	67	39	15
7 Expected Grades	52	35	44	41	67	63	**37**	38	17
8 (Actual Grades)	12	02	31	28	15	15	20	**65**	49
9 (STEP-Math)	08	02	23	22	13	14	15	43	**61**

*Fall (pre) scores shown below diagonal

Spring (post) scores shown above diagonal

Fall-spring correlations for same scales shown on the diagonal

Considering the correlations at the beginning of the year for the graphic-scale scores, the pattern of empirical relations among these variables appears to fit a logical classification which would distinguish three separate categories of variables: (1) External indices of proficiency in mathematics - grade and achievement test scores. (2) Attitudes toward the subject matter per se - indices of intrinsic interest, perceived utility and general mathematics attitudes and interests. (3) Pupil judgments or perceptions of their own proficiency or ability to successfully achieve the goals implicit in the subject matter - indices of ease-of-learning, perceived knowledge and expected grades. In the correlation tables the variables have been grouped in accordance with these categories.

The general tendency toward higher interrelations for measures within these categories than for measures between categories provides the empirical support for this grouping. This pattern of relations is not quite so clear for the post (spring) g - s scores nor for the correlations obtained using r - p scores. (It should be noted for the latter, however, that r - p score equivalents were not determined for the Aiken and Dutton scales, grades, or the mathematics proficiency test scores, which would tend to reduce the correlations between these measures and those for which r - p scores were obtained.)

It is evident that the correlations between the attitude and interest indices and the measures of proficiency (achievement test and grades) were relatively low, indicating that the attitude and interest indices were not reflecting to any predominant extent factors in common with measured proficiency or classroom performance. This is especially evident for the proficiency test which represented among these measures the clearest index of mathematics proficiency, as such.

The correlations between the separate attitude and interest indices, especially at the beginning of the year, were not so high as to preclude their being measures of conceptually independent factors or characteristics, but were sufficiently high to indicate that a common, general attitude factor was being reflected in each of them.

In general, the relations among scores at the end of the year tended to be higher than those at the beginning of the year. This suggests that a general factor came to have a predominant effect on what were at the beginning of the year more independent attitude dimensions and/or pupil characteristics.

3. Summary and Discussion

For the most general measures of interest in and attitude toward mathematics, as provided by the Aiken and Dutton scales, there appeared to be no indication of an overall differential effect for the E programs. Only for the UICSM program was any difference observed for these measures and this resulted from a difference for girls having initially lower interests. Among the latter, those instructed with the UICSM program did exhibit higher interests than those instructed by the same teachers with conventional programs.

Considering the specific attitude and interest indices there was some evidence that pupils instructed with the Ball State program tended to develop less positive attitudes than pupils instructed with conventional programs. This was most clearly indicated for the g - s scores on the Perceived Utility index and for the r - p scores on the Intrinsic Interest and Perceived Knowledge indices. At the same time for the UICSM instructed pupils there were indications of the development of somewhat more positive attitudes than for those in the conventional program classes taught by the same teachers. This was most clearly indicated on the Perceived Utility index for both g - s and r - p scores which however required some qualification as noted below. Similar differences for girls alone were also found on the Intrinsic Interest index.

In general, considering the results from the main analyses for all of the attitude indices, there were some indications that the E programs effected the development of differential attitudes. These effects tended toward less positive attitudes for the pupils instructed with Ball State program and toward more positive attitudes for those instructed with the UICSM program with no very consistent differences observed for the SMSG program. In addition there were indications that pupils instructed with each of the E programs experienced more difficulty learning the subject matter than pupils instructed with conventional programs. For the most part, however, none of the differences was very large, accounting for a relatively small proportion of overall score variance in each instance.

Examination of several instructional factors to determine their contribution to the attitudinal outcomes revealed large instructional program differences in pupil judgments of their instructional materials. Both the Ball State and SMSG instructed pupils reported relatively greater difficulty understanding their texts much more frequently than did conventional class pupils. The UICSM pupils, however, did not differ in this respect from the C class pupils with whom they were compared. Further analyses also indicated that "textbook difficulty" was a factor related to change in pupil attitude over the year.

Separate analyses considered grading differences and indices reflecting teacher evaluations of their experimental programs as factors contributing to E - C differences. No evidence was obtained to indicate that either of these factors varied between pupils in any of the E or C classes being compared, although there was some evidence that in general change in grade was related to change in attitude.

The effect of the teacher's experience with the E programs was also examined. The only difference observed was on the Ease of Learning index for the SMSG teachers where greater learning difficulty among

E class pupils was observed for teachers who had the greatest amount of experience with the E program. This result is somewhat difficult to explain and since it involved a small number of teachers and was not consistently observed should be supported by further evidence before it is considered to be a general effect associated with the SMSG program.

Comparisons were also made to determine whether instructional program differences varied with certain relevant pupil characteristics such as sex and proficiency in mathematics. From the analyses carried out, there was no evidence that the E programs had any differential effects on the attitudes of pupils of higher or lower levels of proficiency in mathematics using as a measure of proficiency test scores obtained at the beginning of the year. Although there appeared to be indications that the instructional program effects varied between sexes for certain attitude indices when g - s scores were used, similar indications were not obtained when sex differences were assessed directly for r - p scores on the same index. It is possible that there was a sex difference in response style or other factors specific to the g - s scores. Examination of the moderating affects for sex and initial pupil proficiency indicated however that the difference observed for the UICSM program could have been due in part to the general effects of these two factors.

Overall the largest instructional program effects were observed for the pupils' judgments concerning the difficulty of the instructional materials. However, in spite of the rather large differences in this regard for pupils instructed with the Ball State and SMSG programs, the attitude differences for these pupils were not of a similar magnitude. This may reflect in part the stability of the attitudes being measured in general, that is, the tendency for the initial attitudes to be sustained by a number of different factors or conditions, some of which may have operated to counter the negative effects of the text difficulty factor.

With respect to subsequent studies, the results of the above analyses suggest that more equivocal results might be obtained if the analyses concerned with the instructional treatment differences provided for tighter control of existing (i.e. initial) pupil characteristics such as sex and mathematics proficiency and adjusted for any attitudinal effects associated with change in teacher assigned grades.

B. Second Year Study

Attitude and interest indices were obtained via questionnaire from a second sample of ninth grade algebra classes available through participation in the achievement study during the 1965-66 school year. This data was gathered to make further assessments of the effects of the experimental programs on a separate sample of classes using revised versions of several of the specific attitude indices. This data was gathered to determine the generality of the results obtained for the first year study and to test more directly hypotheses generated from the results and analysis for the first year data.

1. Method

a. Sample

The sample consisted of twenty-one pairs of ninth grade algebra classes (one E and one C) of teachers participating in the achievement study during the 1965-66 school year. The basis for and conditions of participation were described above in connection with the first year questionnaire study. The sample included classes of teachers who had participated in both the achievement and attitude study the previous year, some who had participated in the achievement study but due to some limitations in the nature of their participation had not been included in the attitude study and some teachers who were participating in the achievement study for the first time.

Table 28 shows for those included in the analysis the number of teachers using each of the experimental programs in their E classes and the number of previous year's experience the teachers had using that program.

Table 28

Number of Teachers Following Each E Program and the Number of Previous Years Experience with That Program

Number of Previous Years	Ball State	UICSM	SMSG	Total
3	1	2	0	3
2	2	1	1	4
1	1	1	3	5
0	1	2	1	4
Total	5	6	5	16

Within the sample of classes from whom data had been gathered, the data for the classes of five teachers was not included in this analysis due to either large differences between the E and C classes with respect to initial proficiency and previous performance (three teachers) or to there being only a very small number of pupils for whom sufficient data was available (two teachers).

b. Measuring instruments

Instructional program comparisons were made using the Aiken Interest Scale and the several indices measuring the specific attitude or interest dimensions used in the previous study; all of which have been described above (SectionIV Alb). These were the Intrinsic Interest, Perceived Knowledge, Perceived Utility, and Ease of Learning indices. For each of the latter indices an attempt was made to improve their internal consistency and general reliability and to obtain more independent and unique measures of the dimensions they were intended to reflect. This was done by the addition, revision or deletion of items in the questionnaire on the basis of data obtained from the pupil response to the items the previous year. The main result of the item evaluation was the development of a number of additional items for the Intrinsic Interest and Perceived Knowledge indices.

Within the questionnaire, the item response format and procedure was the same as for the questionnaire used the previous year, i.e. pupils responded to each item on a five-point graphic scale, for each of the academic subjects in which they were enrolled; mathematics, English, science, social studies and foreign language. (See Appendix A) Graphic scale response values were determined by the physical distance of the response given for mathematics on each individual item scale. The response values for each item were then normalized (i.e. converted to z-scores) on the basis of the response distribution for the item for the entire sample of pupils. Pupil scores on each indices were obtained by averaging the normalized values for the responses given by the pupil to the items in a specific index. The individual pupil scores for each indices were converted to standard scores with a mean of 50 and a standard deviation of 10.

The comparisons for the second year sample were made using for the most part the indices scores obtained from the graphic scale response values.

To obtain a measure of general proficiency in mathematics at the beginning of the year and of algebra achievement at the end of the year, the Mathematics section of the STEP and the COOP Algebra II test[12] respectively were administered to pupils in the sample.

c. Data gathering procedures

The data gathering procedures were essentially the same as those followed for the previous year which have been described above.
Arrangements were made to have the questionnaires containing

[12]Published by Educational Testing Service, Princeton, New Jersey, 1965

the various attitude and interest indices and pupil reactions and judgments concerning the instructional materials and conditions, administered near the beginning and again near the end of the school year. Scores on pre and post measures of mathematics proficiency and achievement were also obtained for pupils in most of these classes as were the grades they had received in mathematics during the ninth grade and during the previous year.

d. <u>Method of Analysis</u>

To determine the instructional program effects on change in pupil attitude and interest, a three-factor analysis of covariance was used. Instructional treatment (E or C class), teacher and pupil sex were the three dimensions. All of the dimensions were crossed with the analyses being carried out separately for each of the E programs.

Two covariates were considered in the analysis. One covariate was the premeasure of the attitude index being examined. This provided for the program comparisons to be made in terms of individual attitude change relative to that expected for the entire sample, i.e., relative to the regression of the pre on the post measure for a given index. The other covariate was an index of change in average mathematics grade from the previous to the concurrent year. The absolute difference between a numerical equivalent of the average grade the pupil had received during the previous year (eighth grade) and during the ninth grade year was used as the index of grade change.[13] Since the central question concerned the effects of the instructional programs, as such, independent of the effects of other conditions in the instructional situation, grade change as a covariate provided a control for any differences in this regard between E and C class pupils.

The specific questions to be answered by this analysis were:

a) Whether there was a differential change in attitude toward mathematics between E and C class pupils independent of initial attitude and any change in mathematics grade?

b) Whether there was any variation in the instructional program effects among teachers, i.e., a treatment by teacher interaction?

[13] This index was used rather than an index representing the deviation of the post grade (algebra grade) from the regression of pre (eighth grade) on post grade because it afforded greater computational ease within the computer program used to carry out this analysis.

c) Whether there was any variation in the instructional program effects between sexes, i.e., a treatment by sex interaction?

The formal model and relevant descriptive information for this analysis is given in Appendix D .

Preliminary to the analysis of covariance, a test of the assumption of homogeneity of the within cell (treatment x teacher x sex) regression coefficients (i.e. beta coefficients) generated by the two covariates was carried out for each E program comparison condition. The criterion for accepting the assumption of homogeneity of within cell regression was a probability level of .10 . Where this assumption was rejected when all classification cells were considered, further tests were carried out to determine if the significant variation in regression was due to a systematic difference in this regard between the E and C programs. Homogeneity of regression was also examined among both the teacher (across sex) and teacher by sex marginal categories.

An indication of regression homogeneity within the respective E and C conditions when not observed across all cells (i.e. across the E - C conditions) would in itself reflect one type of instructional program effect -- a program by covariate interaction effect. The latter effect, however, because it indicates a different covariate adjustment would be required for the E and C conditions, would preclude further comparisons with an adjustment for the specific covariate. Lack of homogeneity both within and across treatment categories would suggest, on the other hand, that nonhomogeneity was a result of factors other than the instructional program. Under the latter condition, for this analysis, it was felt that the nonhomogeneity was most likely due to a grade-change regression variation between teachers that had resulted from variations in teacher grading practices. Consequently, where nonhomogeneous regression was indicated both within as well as across treatment conditions, the grade-change covariate was dropped from the analysis and the analyses were carried out using only the premeasure of the dependent variable as a covariate, if homogeneity for the latter was indicated. The analysis considering only the premeasure as a covariate would be less sensitive in the sense of having a larger error term than if grade-change were included <u>and</u> the regression slopes were homogeneous. Exclusion of this possible statistical adjustment however would not have a systematic effect on the E - C differences when the homogeneity tests indicated that the slope variations were unrelated to the instructional program difference.

2. Results

a. Program effects on attitude and interest indices.

The preliminary test of the homogeneity of the regression coefficients for both covariates, shown in Appendix E , indicated that this assumption could not be accepted for all comparisons.[14] In each instance where the assumption could not be accepted, nonhomogeneity also occurred both within and between the program treatment conditions and, consequently, the analysis in these cases was carried out with the attitude index premeasure as a single covariate. For the latter analysis in each comparison condition, with one exception, (Perceived Utility index, SMSG) regression homogeneity was obtained when the single premeasure covariate was used. Because of the nonhomogeneity of variance with either covariate, analysis of covariance was not used for the comparisons on the Perceived Utility index for the SMSG condition. For this comparison, analysis of variance was used following the design employed in the first year study which included blocking (two levels) on the premeasure.

Table 29 shows the unadjusted and adjusted Aiken Scale means obtained for each E program comparison condition and the beta coefficients for each covariate for which the adjustments were made. Table 30 provides a summary of the analysis of covariance results obtained on the Aiken Scale. For none of the E program comparisons were the instructional program differences reliable at the .05 level, although for both the UICSM and SMSG comparisons the probability level for the difference was less than .10 . In both of the latter comparisons, C class pupils had the higher interest scale scores. In none of the E program comparisons on this measure were the treatment by teacher or the treatment by sex interactions significant.

The unadjusted and adjusted Intrinsic Interest index means are shown in Table 31 with the summary of the analysis of covariance results shown in Table 30 . For the Ball State program comparison, pupils instructed with the conventional program exhibited a reliably higher mean intrinsic interest score than those instructed with the Ball State program. No variation in this difference was indicated between sexes or among teachers. For the UICSM and SMSG program comparisons, no reliable treatment differences or reliable treatment interactions were indicated for the index of intrinsic interest.

The means obtained on the Perceived Utility, Perceived Knowledge and Ease of Learning indices are shown in Tables 31 and 32 and the summary of analysis of covariance results for these indices are shown in Table 30 . The means and analyses of variance results on the Perceived Utility index for the SMSG comparison are shown in Tables 33 and 34 . On none of these indices for any of the E program

[14] Non homogeneity for two covariates was indicated for the following attitude index and E program comparison condition combinations: Aiken Interest Scale, UICSM; Intrinsic Interest, SMSG; Perceived Knowledge, Ball State and SMSG; Utility, SMSG.

TABLE 29

Unadjusted and Adjusted Unweighted Aiken Mathematics Interest Scale Means for E and C Class Pupils by Sex

		Unadjusted			Adjusted		
	Sex	M	F	Ave.	M	F	Ave.
Program	Treatment						
Ball State	E	3.31	3.30	3.30	3.29	3.24	3.27
	C	3.64	3.36	3.50	3.46	3.32	3.39
Covariate beta weight		{ Premeasure				.79	
		{ Grade change				.06	
UICSM							
	E	3.15	3.01	3.08	3.03	3.05	3.04
	C	3.07	3.21	3.14	3.16	3.16	3.16
Covariate beta weight		{ Premeasure				.87	
		{ Grade change				a	
SMSG							
	E	3.28	3.06	3.17	3.36	3.36	3.36
	C	3.39	3.34	3.36	3.46	3.54	3.50
Covariate beta weight		{ Premeasure				.83	
		{ Grade change				.07	

[a] Grade change was not included as a covariate in the analysis.

TABLE 30

Summary of Results of Analysis of Covariance
On Each Attitude and Interest Measure

	d.f.	AIKEN SCALE M.S.	AIKEN SCALE F	AIKEN SCALE p	INTRINSIC INTEREST M.S.	INTRINSIC INTEREST F	INTRINSIC INTEREST p	PERCEIVED UTILITY M.S.	PERCEIVED UTILITY F	PERCEIVED UTILITY p	PERCEIVED KNOWLEDGE M.S.	PERCEIVED KNOWLEDGE F	PERCEIVED KNOWLEDGE p	EASE OF LEARNING M.S.	EASE OF LEARNING F	EASE OF LEARNING p
Ball State																
Treatment	1	23.0	<1.0		237.2	5.39	*	64.6	1.03		5.0	<1.0		31.7	1.33	
Sex	1	8.3	<1.0		205.5	4.62	*	713.9	11.37	***	0.0	<1.0		0.0	<1.0	
Teacher	4	45.2	1.52		114.9	2.59	*	159.0	2.53	*	133.4	2.64	*	81.5	3.43	**
Tr X S	1	65.4	2.21		27.1	<1.0		32.7	<1.0		165.5	3.27		72.6	3.05	
Tr X Te	4	32.8	1.11		30.4	<1.0		67.4	1.07		39.6	<1.0		8.0	<1.0	
Te X S	4	71.6	2.42	*	17.7	<1.0		12.0	<1.0		26.0	<1.0		1.5	<1.0	
Tr X Te X S	4	12.7	<1.0		71.8	1.61		119.1	1.90		54.9	<1.0		7.8	<1.0	
Error M.S.		29.6			44.4			62.8			51.0			23.8		
d.f.		196			155			155			200			155		
UICSM																
Treatment	1	78.8	2.83	ϕ	16.5	<1.0		11.1	<1.0		8.3	<1.0		154.6	2.06	
Sex	1	1.0	<1.0		132.4	2.31		173.9	7.35	**	132.0	2.17		188.6	2.51	
Teacher	5	58.0	2.09		147.2	2.57	*	96.0	4.06	**	226.2	3.71	**	98.5	1.31	
Tr X S	1	0.7	<1.0		21.7	<1.0		19.6	<1.0		0.7	<1.0		0.1	<1.0	
Tr X Te	5	27.2	<1.0		40.1	<1.0		10.0	<1.0		41.6	<1.0		73.7	<1.0	
Te X S	5	43.7	1.57		12.7	<1.0		21.7	<1.0		33.9	<1.0		48.8	<1.0	
Tr X Te X S	5	126.9	4.56	***	79.6	1.39		27.7	1.17		103.0	1.69		83.2	1.11	
Error M.S.		27.8			57.2			23.7			60.9			75.1		
d.f.		218			204			204			204			204		
SMSG																
Treatment	1	75.2	2.87	ϕ	106.8	1.77		(The results for			11.1	<1.0		0.4	<1.0	
Sex	1	16.1	<1.0		1.7	<1.0		the SMSG compari-			529.1	2.33		42.8	<1.0	
Teacher	4	18.6	<1.0		74.0	1.22		son on this index			76.7	1.14		75.4	4.94	***
Tr X S	1	18.0	<1.0		113.5	1.88		are shown in a			48.5	<1.0		1.2	<1.0	
Tr X Te	4	13.7	<1.0		67.9	1.12		separate Table)			119.8	1.78		24.5	1.60	
Te X S	4	211.7	8.07	***	362.9	6.00	***				227.5	3.38	**	45.4	2.97	*
Tr X Te X S	4	22.5	<1.0		49.5	<1.0					14.5	<1.0		6.5	<1.0	
Error M.S.		26.2			60.5						67.3			15.3		
d.f.		188			197						194			178		

* $p < .05$ ** $p < .01$ *** $p < .001$ ϕ $.05 < p < .10$

TABLE 31

Unadjusted and Adjusted Unweighted Mean Intrinsic Interest and Perceived Utility Index Scores for E and C Class Pupils by Sex

		INTRINSIC INTEREST						PERCEIVED UTILITY					
		Unadjusted			Adjusted			Unadjusted			Adjusted		
		M	F	Ave.	M	F	Ave.	M	F	Ave.	M	F	Ave.
Ball State													
E		50.0	50.5	50.2	51.1	49.5	50.3	51.4	46.2	48.8	50.7	46.7	48.7
C		54.8	50.7	52.8	54.7	51.3	53.0	54.6	45.0	49.8	53.1	47.1	50.1
Covariate beta	Premeasure			.54						.43			
	Grade change			.88						.33			
UICSM													
E		46.5	47.2	46.8	47.4	46.4	46.9	48.5	46.9	47.7	49.1	47.0	48.1
C		49.7	46.1	47.9	48.7	46.3	47.5	51.9	48.0	50.0	50.8	48.8	49.8
Covariate beta	Premeasure			.62						.57			
	Grade change			.39						.14			
SMSG													
E		47.9	49.7	48.8	48.1	49.5	48.8						
C		50.4	50.9	50.6	51.2	49.4	50.3						
Covariate beta	Premeasure			.72									
	Grade change			a									

[a] Grade change was not included as a covariate in this comparison.

TABLE 32

Unadjusted and Adjusted Unweighted Mean Perceived Knowledge and Ease of Learning Index Scores for E and C Class Pupils by Sex

		PERCEIVED KNOWLEDGE						EASE OF LEARNING					
		Unadjusted			Adjusted			Unadjusted			Adjusted		
		M	F	Ave.	M	F	Ave.	M	F	Ave.	M	F	Ave.
Ball State													
E		49.2	51.7	50.4	48.4	50.4	49.4	49.1	50.1	49.6	48.6	50.1	49.3
C		53.6	49.3	51.4	50.7	48.7	49.7	49.0	47.7	48.4	49.2	47.7	48.5
Covariate beta	Premeasure			.75						.19			
	Grade change			a						-.34			
UICSM													
E		49.2	47.1	48.2	50.6	48.7	49.7	47.7	50.3	49.0	48.4	50.4	49.4
C		50.5	47.3	48.9	50.9	49.3	50.1	48.6	50.0	49.3	48.9	49.5	49.2
Covariate beta	Premeasure			.71						.22			
	Grade change			.84						-.08			
SMSG													
E		50.2	49.2	49.7	50.9	48.6	49.8	50.0	49.2	49.6	50.0	48.8	49.4
C		51.8	49.8	50.8	52.5	48.1	50.3	49.4	49.2	49.3	49.9	49.0	49.5
Covariate beta	Premeasure									.23			
	Grade change			a						-.05			

[a] Grade change was not included as a covariate in this comparison.

TABLE 33

Adjusted (unweighted) Perceived Utility Index Means for E and C Class Pupils in the SMSG Program Comparison

Premeasure Level	Low			High		
Sex	M	F	Ave.	M	F	Ave.
E	46.9	45.6	46.2	56.0	48.7	52.3
C	48.7	43.8	46.3	56.1	51.2	53.6

TABLE 34

Summary of Results of Analyses of Variance on Perceived Utility Index Scores for SMSG Program Comparison

Source of Variance	d.f.	M.S.	F	p
Treatment	1	4.472	<1.0	
Premeasure	1	454.779	22.73	***
Sex	1	213.096	10.65	***
Teacher	4	9.339	<1.0	
Tr x Pre	1	3.803	<1.0	
Tr x S	1	.752	<1.0	
Tr x Tch	4	13.297	<1.0	
Tr x Pre x S	1	22.764	1.14	
Tr x Pre x Tch	4	27.641	1.38	
Tr x S x Tch	4	54.236	2.71	*
Tr x S x Tch x Pre	4	4.768	<1.0	
Residual	13	27.132	1.36	
Error	179	20.012		

comparisons were the instructional program differences reliable, nor were any significant instructional treatment interactions with either sex or teacher indicated. For the Ball State program comparison on both the Perceived Knowledge and Ease of Learning indices, there was a tendency for the C class boys to have higher means than those instructed with the Ball State program and for the Ball State girls to have higher means than the C class girls. An F-ratio of marginal significance ($p < .10$) was obtained for these differences.

Overall, there was very little indication of instructional program differences of any magnitude on the attitude and interest indices. Pupils in the Ball State program appeared to develop a somewhat lower interest in mathematics than those in the comparison conventional classes as measured by the Intrinsic Interest index. There was also a tendency for UICSM and SMSG instructed pupils to have lower scores on the Aiken scale than those in conventional classes. The latter differences, however, were supported only by a marginal probability level. There were no clear indications of any differential program effects between sexes or among teachers for any of the comparisons.

b. <u>Program effects on attitude relevant instructional conditions.</u>

<u>Textbook Difficulty.</u> In the first year study pupils using the Ball State and SMSG programs reported much more difficulty understanding their instructional materials (the experimental textbooks) than did comparison pupils using conventional materials. This effect represented the most distinctive difference that was observed for the experimental programs. In the second year study an item inquiring about the difficulty of the materials was again included in the post questionnaire. Comparisons were made between E and C class pupils within each E program condition in terms of both the graphic-scale score and the rank-position obtained for responses to the textbook difficulty item.

A three factor (instructional treatment by teacher by sex) analysis of covariance following the design used in this study with the attitude measures was carried out on the text difficulty g - s scores. The pupils score on the premeasure of the Ease of Learning index was used as a covariate to control for initial differences in <u>expected</u> difficulty arising from previous experience with mathematics. Table 35 shows a summary of the results of the analysis of covariance for each E program comparison condition and the adjusted unweighted means obtained for the g - s scores on text difficulty.[15]

For the Ball State program comparison, a highly reliable difference was obtained between the E and C class pupils with those in the E classes reporting greater difficulty with the materials. This difference did not vary in any significant way between sexes or teachers. For the UICSM comparison, the overall program differences were not

[15]For each analysis a test of the assumption of homogeneity of within cell regression coefficients indicated that it was acceptable with $p > .10$.

TABLE 35

Summary of Results of Analysis of Covariance and the Adjusted Unweighted Means Obtained on the Text Difficulty Judgment (g - s Score) for Each E Program Comparison Condition

Source of Variance	Ball State d.f.	Ball State M.S.	Ball State F	UICSM d.f.	UICSM M.S.	UICSM F	SMSG d.f.	SMSG M.S.	SMSG F
Treatment	1	1276	6.7**	1	105	<1.0	1	3173	3.5
Sex	1	6	<1.0	1	22	<1.0	1	1128	6.1**
Teacher	4	731	3.8	5	81	<1.0	4	806	4.3**
Tr X S	1	48	<1.0	1	647	3.3	1	22	<1.0
Tr X Te	4	10	<1.0	5	892	4.5	4	923	5.3**
Te X S	4	99	<1.0	5	298	1.5	4	230	1.2
Tr X Te X S	4	24	<1.0	5	163	<1.0	4	99	<1.0
Error	200	190		218	197		194	186	
Covariate beta weight		.55			.49			.43	

* $p \leq .05$; ** $p < .01$

Adjusted Means

	Ball State E	Ball State C	UICSM E	UICSM C	SMSG E	SMSG C
M	33.4	28.9	37.8	33.0	44.6	37.0
F	34.1	27.5	33.7	35.8	40.3	31.3
Ave.	33.7	28.2	35.8	34.4	42.4	34.2

reliable, however there was significant variation in the E - C differences among teachers and the treatment by sex interaction was very close to the criterion of significance i.e. $.05 < p < .07$. The latter outcome reflected the fact that for boys, those in the UICSM classes reported greater text difficulty while for the girls, greater difficulty was reported by those in the conventional classes. When examined further by an analyses for each sex separately, the E - C difference for boys reached a marginal probability level, $F_{1,218} = 3.2$, $.05 < p < .10$, while the difference for girls did not.

Overall, pupils instructed with the SMSG program reported a higher level of textbook difficulty than those in the comparison conventional classes. However, there was significant variation in this respect among teachers. A consequence of the highly significant teacher by treatment interaction was that the treatment difference that could be generalized was nonsignificant.[16]

For both the UICSM and SMSG comparisons for which teacher by treatment interactions were indicated, further analyses were made to determine if the variations among teachers with respect to E - C differences in text difficulty were associated with the amount of teacher experience with the E program. For the UICSM program no correspondence was observed between the magnitude of the E - C difference for each teacher and the amount of previous experience with the E program. For the SMSG program the magnitude of the E - C difference corresponded directly with the number of years of teacher experience with the E program. The greater the teacher experience the less the amount of text difficulty reported by the E compared to the C class pupils. However, the small number of teachers at each experience level; one with three years, three with two years and one with one year; would preclude any generalization.

Comparisons for the rank-position response to the text-difficulty item were made within levels on the pre EOL index determined by the median of the distribution for all pupils on the EOL index, r - p scores. The comparisons were made combining the first and second rank positions using Chi-square to determine the reliability of the E - C differences. The rank-position frequencies and results of the comparisons are shown in Table 36 .

16 To enable generalization from the data sample to a larger population of teachers and classes, it was necessary that the treatment MS be tested against the teacher by treatment interaction MS rather than the within cell error term because of the magnitude of the interaction term. (See Appendix D for details concerning the analysis design.) If the question were restricted to this specific sample of teachers and classes, then the treatment main effects were significant,

$F = \frac{MS_{treat}}{MS_{error}} = 17.1$, $p < .001$, however, because of the large E - C difference variation among teachers, this difference could not be generalized beyond this sample.

TABLE 36

Text Difficulty Rank Frequency Comparisons Between E and C Class Pupils, Second Year Study

	Pre EOL level	Text diff. rank	M E	M C	M Total	F E	F C	F Total	M + F E	M + F C	M + F Total
BALL STATE	Low	1,2	7	25	32	12	8	20	19	33	52
		3	10	13	23	26	13	39	36	26	62
			17	38	55	38	21	59	55	59	114
			χ^2[a] = 2.00			χ^2 = .05			χ^2 = 4.42 *		
	High	1,2	9	25	34	17	19	36	26	44	70
		3	10	9	19	12	6	18	22	14	36
			19	34	53	29	25	54	48	58	106
			χ^2 = 2.58			χ^2 = 1.13			χ^2 = 4.59 *		
UICSM	Low	1,2	13	11	24	7	9	16	20	20	40
		3	21	20	41	23	22	45	44	42	86
			34	31	65	30	31	61	64	62	126
			χ^2 = .00			χ^2 = .05			χ^2 = .01		
	High	1,2	14	17	31	15	12	27	29	29	58
		3	24	16	40	22	19	41	46	35	81
			38	33	71	37	31	68	75	64	139
			χ^2 = 1.01			χ^2 = .01			χ^2 = .38		
SMSG	Low	1,2	2	7	9	9	5	14	11	12	23
		3	26	23	49	25	15	40	51	38	89
			28	30	58	34	20	54	62	50	112
			χ^2 = 1.79			χ^2 = .04			χ^2 = .34		
	High	1,2	3	16	19	12	16	28	15	32	47
		3	20	15	35	13	8	21	33	23	56
			23	31	54	25	24	49	48	55	103
			χ^2 = 7.01**			χ^2 = 1.06			χ^2 = 6.45*		

* $p < .05$, ** $p < .01$

[a] χ^2 computed with Yates correction

For the Ball State and SMSG programs, the rank-position responses indicated differences in the same direction but not of the same magnitude as those obtained on the graphic-scale scores. For the Ball State program, at both pre EOL levels, the frequency differences were reliable only when both sexes were combined. For the SMSG program reliable program differences were obtained only for higher pre EOL (lower expected difficulty) pupils. For the UICSM program, although the r - p responses did not show the treatment by sex interaction tendency obtained for the g - s score analysis, the absence of program difference was shown for both scores.

The difference between the results obtained for the g - s and r - p scores could have been due in part to the fact that the r - p responses provided a less precise measure than the g - s scores. However, it is also evident that the differences obtained using r - p scores for the Ball State and SMSG programs were not as large in this study as they were in the first year study. For the SMSG program, the variation in text difficulty with teacher experience with the E program may in part account for difference between studies since generally the teacher's in the first year study had less experience.

c. <u>Properties of and relations among the attitude and interest indices and proficiency measures.</u>

Table 37 shows the internal consistency reliability coefficients for the attitude and interest indices used in this study. The reliabilities for the Intrinsic Interest and Perceived Utility indices are somewhat higher than obtained for the first year study reflecting the revision and addition of items for these measures.

Table 38 shows the intercorrelations among the attitude, interest and proficiency measures obtained at the beginning and end of the year. The correlations between attitude and interest indices and measures of proficiency show as in the first year study that there was some degree of independence between these two types of measures. However the pattern of intercorrelations generally differed somewhat from that obtained for the first year study, especially those relations obtained at the beginning of the year. In this study the Intrinsic Interest and Perceived Knowledge indices and the Aiken Interest scale were all more highly intercorrelated than in the first year study. The addition of items to these indices which contributed to their higher reliability also apparently increased their tendency to assess a more general attitude factor and thereby probably reduced somewhat the extent to which they assessed the more specific independent attitudinal dimensions they were developed to measure. Also the Ease of Learning index generally exhibited lower correlations with other indices than had been the case the previous year. There is no obvious explanation for this difference.

TABLE 37

Coefficients of Internal Consistency Obtained for Attitude and Interest Indices

(Second Year Study, Graphic-scale Scores, N = 575)

Measure	Fall Administration	Spring Administration
Intrinsic Interest	85	92
Perceived Utility	74	75
Perceived Knowledge	88	93
Ease of Learning	68	84
Aiken	a	96

[a]Not completed for the Fall Administration.

TABLE 38

Correlations Between Attitude and Interest Indices and Measures of Achievement

(Second Year Study, N = 575)

Measure	1	2	3	4	5	6	7	8
1 Intrinsic Interest	$\boxed{64}$	57	81	75	31	55	51	42
2 Perceived Utility	45	$\boxed{50}$	50	48	16	29	28	22
3 Aiken	74	38	$\boxed{72}$	76	37	58	55	46
4 Perceived Knowledge	71	40	66	$\boxed{61}$	38	75	68	57
5 Ease of Learning	43	18	57	46	$\boxed{40}$	32	30	24
6 Expected Grade	53	26	58	61	51	$\boxed{53}$	75	53
7 Actual Grade	23	08	31	29	21	49	$\boxed{65}$	65
8 Achievement Test	16	13	28	28	26	40	46	$\boxed{51}$

d. <u>General instructional factors and conditions affecting attitude change</u>

In both the previous and present studies, there were indications that pupils instructed with the Ball State program had developed less positive attitudes toward mathematics and had greater difficulty with their instructional materials than pupils in the conventional comparison classes. Also in the first year study, there was a significant relationship between change in attitude and the amount of text difficulty reported. These results suggest that the difficulty characteristic of the Ball State instructional materials may have been a factor affecting the pupil's more general attitudes toward mathematics and consequently may have contributed to or affected the attitude differences observed for pupils instructed with this experimental program. To determine the extent that text difficulty affected the attitude differences indicated for the Ball State program, further comparisons were made between the E and C class pupils on several attitude measures with adjustments for the affects of the text difficulty factor. The comparisons were made using analysis of covariance considering three factors, instructional treatment, teacher and pupil sex, with measures of change in text difficulty and in mathematics grades as covariates.[17]

Relative change scores for each of the variables, text difficulty, grade and attitude, were used in the analysis. The change scores were deviations of the <u>actual</u> post scores from post scores predicted by the premeasure of each variable, i.e. the actual deviations from the score expected on the basis of the linear regression of the post on premeasure of each variable.[18]

[17] Mathematics grades were included as a covariate for two reasons. (1) Adjustments had been made for this factor in the earlier analysis examining instructional treatment effects on the attitude indices. (2) Adjustments for text difficulty as the only covariate would be based upon a within cell estimate of the text difficulty affect on the attitude measure. Such an adjustment however would reflect the regression effects of factors other than text difficulty, that is factors correlated with text difficulty and attitude such as grades. Because the within treatment affect of such correlated factors as grades would not represent a between treatment effect, such factors should not logically contribute to a between treatment adjustment. Including the mathematics grade variable explicitly as a covariate precludes the over adjustment that would otherwise result.

[18] For text difficulty the premeasure was the pre EOL index score, for grade the premeasure was the previous year's average mathematics grade, the post measure the concurrent year's average grade.

A summary of the results of the covariance analysis on change in attitude as measured by change scores on the Aiken Interest Scale, and the Intrinsic Interest, and Perceived Utility indices when adjusted for change in text difficulty and grades are shown in Table 39 . For none of the indices were reliable treatment main effects or interactions obtained. The lack of a significant treatment difference on the Intrinsic Interest index when adjustment was made for the text difficulty affects indicates that the significantly lower score exhibited on this index by Ball State pupils was associated with and presumably the consequence of a higher level of difficulty with the instructional materials for these pupils than for those in the comparisons conventional classes. The fact that no treatment differences were observed generally on these indices when the text difficulty adjustment was made indicates further that the latter factor was not masking other attitude change effects of the Ball State program and suggests that the only instructional program connected factor effecting attitude change in this comparison was text difficulty.

The differential effects of the alternate programs of instruction on the self-report measures of pupil attitudes toward mathematics were found to be quite small. One reason for this could have been that these attitudes were quite stable having been firmly established prior to the ninth grade and consequently, relatively immune to variations in conditions of instruction in the ninth grade. However, to the extent that there was no change in the attitudes measured by the various indices, the correlations between the pre and post scores obtained on the indices over the period of instruction would have approached the magnitude of their estimated internal consistency reliability coefficients. That there was some degree of difference between the two coefficients for each of the attitude indices can be seen by an examination of Tables 37 and 38 , which indicate quite clearly that a fair amount of attitude change did occur over the period of instruction.

An estimate of the proportion of variance that could be attributed to change over the year on a given attitude measure could be obtained by subtracting the maximum variance common to the pre and post measures from the total post score variance of the attitude measure. The maximum variance common to two measures is the square of the *true* correlation between them, in this case between the pre and post measures. The *true* correlation is the observed correlation adjusted for unreliability or *attenuation*. The true correlation between two measures x and y, symbolized $r_{\alpha\alpha}$ is usually given as

$r_{\alpha\alpha} = \dfrac{r_{xy}}{r_{xx}r_{yy}}$. The maximum variance common to both measures is

therefore $r^2_{\alpha\alpha}$.

TABLE 39

Summary of Results of Analysis of Covariance on Interest Change Scores with Text Difficulty and Grade Change as Covariates in the Ball State Program Comparison

Source of Variance	Aiken Interest Scale d.f.	Aiken Interest Scale M.S.	Aiken Interest Scale F	Intrinsic Interest Index M.S.	Intrinsic Interest Index F	Perceived Utility Index M.S.	Perceived Utility Index F
Treatment	1	.23	<1.0	49.1	<1.0	12.5	<1.0
Sex	1	1.81	<1.0	166.5	4.78*	589.7	10.1**
Teacher	4	1.42	<1.0	88.1	2.53*	141.2	2.4
Tr X S	1	.68	<1.0	29.6	<1.0	24.8	<1.0
Tr X Te	4	.60	<1.0	75.7	2.17	84.6	1.4
Te X S	4	3.94	1.91	20.0	<1.0	4.2	<1.0
Tr X Te X S	4	.90	<1.0	43.8	1.26	97.7	1.7
Error	149	2.1		34.8		58.7	

* $p<.05$
** $p<.01$

Using the pre-post correlation given in Table 38 for the value of r_{xy} , and the pre and post internal consistency reliability coefficients given in Table 37 for the values of r_{xx} and r_{yy}, the proportion or total variance that is maximum common variance and the residual variance, which is the proportion of variance to be accounted for by other factors thereby representing the variance for individual score change, is given below for the several attitude measures:

Measure	Maximum Common Variance	Residual, (Change Variance)
Aiken Scale	.56	.44
Intrinsic Interest	.47	.53
Perceived Utility	.45	.55
Perceived Knowledge	.45	.55

A further question that could be considered then concerns the factors that were in general contributing to or associated with the attitude change that occurred. Within the study there were several variables that could be identified as possible sources of effects on pupil attitudes. Consequently, some additional analyses were carried out to determine the contribution of these variables to attitude change in general in terms of the proportion of attitude change variance that could be accounted for when all pupils in the sample were considered independent of their specific program of instruction.

A preliminary analysis indicated that among several alternate measures,[19] grade change and text difficulty (technically, experienced text difficulty since this index was adjusted for initial expected difficulty) were the only measures accounting for a sufficient proportion of independent attitude change variance to justify more detailed consideration.

Treating text difficulty and grade change as predictor variables, a multiple linear regression analysis was carried out on change measures for each of the several attitude and interest indices. The analysis permitted differentiating between the proportion of variance on the attitude

[19] The other measures considered were an index of "effort input" derived from questionnaire items concerned with amount of mathematics class homework, the index of general learning difficulty and an alternate index of performance, the absolute grade change measure. None of these measures accounted for any significant amount of attitude change variance independent of the text difficulty and/or relative grade change measures.

change measure that represented the specific or independent contribution of the grade change variable, the specific or independent contribution of the text difficulty variable, and the contribution common to both variables, as well as the general contribution of each variable separately and combined (their respective specific contributions plus the common contribution). The results of this analysis are shown in Table 40 .

TABLE 40

Percent of Change Variance Accounted for by Text Difficulty and Grade Change Independently and Combined for Each Attitude and Interest Measure

Measure	Text Difficulty Specifically (a)	Grade Change Specifically (b)	t.d and g.c. in Common (c)	t.d alone (a+c)	g.c alone (b+c)	Both t.d and g.c. (a+b+c)
	Proportion of attitude change variance accounted for by -					
Aiken	3.49	6.43	3.71	7.20	10.14	13.63
Intrinsic Interest	7.94	6.10	4.68	12.62	10.78	18.72
Perceived Utility	2.76	1.20	1.05	3.81	2.25	5.01
Perceived Knowledge	1.32	14.25	3.35	4.67	17.60	18.92

For all of the measures the proportion of variance accounted for by each of the variables independently was quite significant statistically ($p < .01$). The results show that grade change and text difficulty each accounted for an independent proportion of the attitude change variance which indicates that the text difficulty judgment represents a relatively independent reaction to the instructional materials rather than simply a reflection of factors connected with the pupils' performance. The relative proportion of attitude change variance accounted for by each of these variables also varied among the separate attitude measures with text difficulty having a greater effect on the Intrinsic Interest index than on the other attitude measures and grade change having a greater effect on the Perceived Knowledge index.

The latter observation would seem to suggest that factors reflecting directly characteristics specific to the instructional content and/or materials have a greater effect on intrinsic interest in mathematics than on the pupils' judgments of his proficiency in this area. It was possibly for this reason that the differences for the Ball State program occurred only on the Intrinsic Interest index.

Although for several of these measures, text difficulty and grade change account for a moderate proportion of the attitude change variance it is evident that there was a sizeable proportion of residual variance not accounted for by these variables, at least when included in a linear prediction model of the type used here.

C. Summary and Discussion of Results Obtained from Self-Report Indices

With respect to indices of attitude and interest, the first year study provided some evidence that in comparison with pupils instructed by the same teachers with conventional programs, those instructed with the Ball State program developed less positive attitudes towards mathematics, while those instructed with the UICSM program developed more positive attitudes toward mathematics. The evidence was somewhat stronger for the Ball State than for the UICSM program and further analysis showed that there may have been some uncontrolled concommitant factors contributing to the UICSM program differences. For the SMSG program in the first year study there were only very limited indications of any differential effects on pupil attitudes toward mathematics. For pupils instructed with each of the E programs, there were indications of more general learning difficulty, as measured by an index of ease of learning, than for pupils receiving instruction with the conventional programs. The latter effect appeared to be somewhat greater for the Ball State program. For the most part, none of these effects were very large nor were the differences highly reliable in a statistical sense.

Examination of pupil reaction to attitude relevant characteristics of the instructional programs in the first year study revealed that pupils instructed with the Ball State and the SMSG programs experienced greater difficulty understanding their respective materials (the E textbooks) than C class pupils. Similar differences did not appear for the UICSM program. Correlational data indicated that the textbook difficulty factor was related to indices of attitude change suggesting that this characteristic of the instructional materials may have contributed to the attitude differences observed for the Ball State program.

In the second year study, fewer differences were observed on the attitude indices for the E programs than had been the case in the first year study. This may have been the result of the use of an analysis which provided for closer control of concommitant factors. Nonetheless, for each of the E program comparisons, there were some differences which indicated that, if anything, less positive attitudes had developed for pupils instructed with the experimental programs. However, only for the Ball State program on the Intrinsic Interest index, was a difference of this nature beyond a marginal level of probability. The generally greater learning difficulty that had been observed for each of the E programs in the first year study did not appear as a difference for any of the E programs in the second year study.

In the second year study, the Ball State program was also the only program for which a generally higher level of textbook difficulty was indicated. For the SMSG program, the differences in this respect varied to a great extent among the teachers and in accordance with the amount of experience the teacher had using the E program. The latter result suggested that for the SMSG program, teacher experience using the program could have offset pupil difficulties with the instructional materials. Further analyses determined that the text difficulty factor could account for the differential attitude change observed for the Ball State pupils. There was on the other hand no evidence that in the absence of the negative text difficulty factor the Ball State program would have contributed to the development of relatively more positive attitudes than had the conventional programs.

In the first year study, teacher judgments or attitudes concerning the E programs, their experience (number of years) using these programs as well as initial pupil proficiency in mathematics and pupil sex were examined as factors that could effect or modify the attitudinal effects of the instructional programs. In general none of these factors was found to have a consistent or reliable effect of any magnitude on the attitude differences between the E and C programs.

Data obtained concerning the properties of the specific attitude and interest measures indicated that these indices were sufficiently reliable to provide the group comparisons being carried out in this study. A very high level of reliability was shown for the indices assessing a general interest in mathematics. Interrelations among the various attitude and interest indices showed that these measures were reflecting factors quite independent of those assessed by test and grade measures of proficiency or achievement in mathematics. Among the attitude and interest indices however, there were sufficiently high intercorrelations to suggest that a general affective factor was being reflected to a predominant degree in each measure. This was true to the extent that it would be difficult to conclude that differences observed on a given index occurred only for factors specific to that index, as such, especially since the actual magnitude of the differences observed on the separate indices was not very large.

Additional analyses showed that the lack of larger instructional program differences was not due to the fact that the attitudes being measured did not change over the period of instruction. Approximately one-half of the variance on the post attitude measures represented variation due to change from the premeasure. An assessment of the contribution to attitude change of two variables that appeared to be quite relevant to the attitude outcomes, textbook difficulty and relative change (from eighth to ninth grade) in teacher assigned mathematics grades indicated that both of these variables contributed independently to change on each of the attitude measures. The contribution to attitude change associated independently with each of these measures varied between the indices and in most instances represented a moderate proportion of the total change variance. Of significance here was the observation that a quality of the instructional materials as such, textbook difficulty, contributed to change on an index of intrinsic interest in mathematics to the same degree as did a variable which would seem to represent for the pupil a very salient and objective attitude relevant factor in the instructional situation generally, change in performance evaluation or grade received. Moreover, the fact that change in perception of knowledge was more highly related to or affected by a change in grade while change in intrinsic interest was affected more by an independent quality of the instructional materials, text difficulty, provides some empirical evidence that measures of these two assumed dimensions of attitude were reflecting independent factors in spite of their fairly high correlation. Also this observation was consistent with the fact that the instructional program differences occurred on the Intrinsic Interest rather than the Perceived Knowledge indices and suggests that the latter dimension was apparently less sensitive to qualities of the instructional program.

V. INSTRUCTIONAL PROGRAM EFFECTS OBSERVED ON OVERT BEHAVIORAL INDICES OF INTEREST IN MATHEMATICS

As suggested in the more general discussion above, to the extent that a pupil has developed an intrinsic interest in mathematics, he would be expected to exhibit a willingness to expend time and effort in situations or activities concerned with or involving the use of mathematics. In connection with this project, observations were made, subsequent to instruction with one of the alternate programs, of pupil response to situations allowing a choice that would permit greater participation or involvement in mathematics of either an academic or recreational nature, that is situations that would provide overt behavioral indications of mathematics interest. The overt behavioral indications of pupil interest obtained as part of the project were:

1. Pupil response to an opportunity to obtain recreational materials involving mathematics.

2. The amount of pupil reading of library materials in mathematics

3. Pupil enrollment in subsequent advanced mathematics subjects in high school.

The inference that a positive response in such situations represented some degree of intrinsic interest in mathematics assumes that such a response was not motivated primarily or exclusively by extrinsic factors i.e. the achievement of unrelated goals and objectives. On the other hand, the inference that the lack of a positive response represented a lesser degree of intrinsic interest assumes, among other things, that the pupil clearly perceived a given situation as one in which his existing interests or inclinations in this regard could be satisfied. Consequently, to the extent possible in connection with these situations,attempts were made to reduce the possibility of pupils' responding favorably on the basis of extrinsic factors and to increase their awareness of aspects of the situations that appeared relevant to an interest in mathematics.

However, for purposes of comparison to assess the effects of alternate programs of instruction on pupil interest, the level of validity of such indices is of less consequence if it can be assumed that; (1) the indices have at least some moderate degree of validity as measures of mathematics interest, and (2) the factors affecting the validity, either positively or negatively, are unrelated to (i.e. occur to the same extent for) the alternate conditions being compared. Both of these assumptions appeared to be warranted.

It was also recognized that any effects of a given program would develop only after some period of instruction with the program. Consequently, observations of effects in terms of overt behavioral indices were made in each instance near the end of or subsequent to the period of instruction.

A. Requests for Mathematics Recreational Materials

1. Mathematics activity bulletin

In this study, pupils were given the opportunity to obtain by request copies of a series of four-page mathematics activity "bulletins" comprised of materials about or involving mathematics. In addition to requests, pupils were also required to engage in bulletin relevant activities as a means of obtaining further issues. The extent to which pupils requested the bulletin and engaged in the relevant activities to obtain additional issues was considered an indication of their level of intrinsic interest in mathematics. Procedures were followed to minimize the possibility of the pupils' bulletin related activities providing obvious extrinsic rewards.

a. Method

Sample. The sample consisted of pupils in a total of 60 pairs of ninth, tenth, and eleventh grade mathematics classes participating in the field study of these experimental programs. Table 41 shows the number of pairs of E and C classes by grade level and experimental program. Each pair of classes was taught by the same teacher at the same grade level.

TABLE 41

Number of Pairs of E and C Classes Following Each Experimental Program at Each Grade Level Included in the Mathematics Activity Bulletin Study

	PROGRAM			
Grade	BSP	UICSM	SMSG	Total
9th	3	2	5	10
10th	5	2	17	24
11th	14	a	12	26
				60

[a] There was no UICSM program for the eleventh grade.

Materials and procedure. A series of six four-page magazine format recreational or mathematics activity bulletins were prepared. The content of these bulletins included general information and articles about mathematics and topics in mathematics (e.g. topology, number systems, logic), activities which demonstrate mathematics principles and relationships, mathematics puzzles and games and in each issue a set of problems of the recreational rather than textbook type. The articles and materials were selected and prepared to cover topics of general interest and to avoid those specific to any particular instructional program. Similar considerations were given to the language and terminology used. A sample copy of one issue of the bulletin is included as Appendix H .

Sufficient copies of the first issue of the bulletin for each of the two classes were sent to teachers of the participating ninth grade algebra, tenth grade geometry, and eleventh grade advanced algebra classes. The teachers were requested to distribute copies to all pupils in the two participating classes. The teachers were also requested to refrain from encouraging (or discouraging) reading or responding to the bulletin either directly or in relation to class assignments. THe general purpose of the bulletin (i.e. assessment of pupil interests) was revealed to the teachers but no indication of any comparison between classes, teachers, etc., was suggested.

Instructions were provided in the first (and each subsequent) issue for obtaining the next issue of the bulletin. The procedure to obtain the second issue and in turn the third issue, consisted simply of the pupil's filling out the addressed postcard enclosed with each copy with his name, home address, grade and school and mailing it. Use of the pupil's home address reduced the possibility that the teacher and other school related factors could influence the pupil's response.

Beginning with the third issue, however, the procedure for obtaining further issues was modified to require pupils to attempt but not necessarily solve, any of the three or four problems included in each issue. Instead of the postcard, a larger form with space for indicating attempted solutions in addition to the necessary pupil information was included for the pupil response with a stamped-addressed envelope. The attempted problem solution requirement was introduced because a request in and of itself for additional issues of the bulletin, although a probable indication of a certain level of interest in mathematics activities and materials, might represent only a passive level of interest. It could also represent other motives, such as a desire to obtain some personal mail or a free magazine, with little actual interest in the content as such. Furthermore, motives at this level might not reflect the more specific interest in mathematics that could possibly by differentially developed by the instructional materials being compared. Consequently it was desirable to obtain an indication of a higher degree of interest and involvement in mathematics materials in terms of relevant effort and activity. So as not to restrict the future requests only to those who felt they had appropriate problem solving or mathematics ability, it was explicitly indicated that a correct solution was not necessary; only an attempt at a solution. Answers were provided in each subsequent issue.

This procedure was required for each issue after issue three up to and including issue number six. Pupils responding to issue number six, i.e. requesting a non-existant seventh issue, were sent a letter indicating no further issues were available, with an explanation of the purpose of the project and thanking them for their interest as well as providing answers to the problems in issue six.

The rate of response to the first issue (approximately 40%) indicated the possibility of a fairly rapid rate of attrition over the entire series of issues, since following the above procedure, if pupils stopped responding, they received no further issues nor the opportunity to request further issues. Therefore, a "priming" procedure was instituted to elicit a more extensive response. Pupils who failed to respond further within a given period of time after making one or more requests were sent the next issue in the series with a note explaining that surplus copies of that issue were available but that to receive further issues required their response in the usual manner. No pupil was, however, "primed" on more than one occasion.

Analysis. The number of separate issues of the bulletin requested by the pupil was considered an indication of his level of interest in the content of the bulletin. The total possible requests a pupil could make ranged from none through six. The number and proportion of pupils in each grade that had total requests at each level and the number and percent making requests for each successive issue are shown in Tables a and b of Appendix F. Over all classes and grades, 36 percent of the pupils made a request for the second issue. Since each request was contingent upon having made a previous request (with the possible exception of one priming issue), the rate of attrition resulted in the number of requests for later issues being quite small. Consequently, for purposes of comparison, pupils were classified according to the following response categories:

N-R: No request - pupils who made no request following receipt of the initial issue.

R: Request - pupils who requested at least one issue; i.e. issue two. Within this general category, two alternate more specific categories were used.

R-NPO: Non-participation requests only - pupils who made requests only for issue two or issues two and three which did not require activity relevant to the bulletin content (i.e. problem solving attempts).

R-P: Participation requests - pupils who requested one or more issues which required attempted problem solutions, i. e. one or more issues beyond issue three.

Underlying this response classification was the assumption that pupils in the R-NPO category had, on the average, a somewhat stronger interest in the bulletin materials and in mathematics in general than pupils in the N-R category and that pupils in the R-P category had, on the average, stronger interests and preferences for the bulletin content and for mathematics and related activities in general than those in the other categories. A comparison to determine the instructional differences was carried out separately for each E program within each grade with pupils in the E and C classes being pooled within the respective instructional categories for teachers following the same E program. To control for differences associated with pupil sex and/or mathematics proficiency, the comparisons between E and C class pupils for each program were made within sex by proficiency level classifications.

Comparisons were made to determine the differences between E and C class pupils with respect to the proportions in each of the three specific response categories (N-R, R-NPO, and R-P). Chi-square was used to test the reliability of category frequency differences. For some comparisons, the frequencies in the separate R-NPO and R-P categories fell below the number necessary to make an appropriate Chi-square test. In such cases, the frequencies for these two categories were combined and the comparisons (using either Chi-square or the Fisher exact probability test) considered only the N-R and R category differences. Results obtained from the latter comparisons would require some qualification since this did not provide as fine nor quite the same qualitative differentiation with respect to interest manifestation as did the specific request categories. Where statistically significant differences ($p < .05$) were obtained considering all three request categories, procedures for partitioning χ^2 outlined by Castellan (6) were used to determine whether the result was attibutable to differences in the R-NPO or the R-P categories.

With respect to mathematics proficiency, pupils were classified according to scores obtained on the mathematics section of Sequential Tests of Educational Progress, Level Two, (STEP) which had been administered at the beginning of the school year. A two level classification was made relative to the median of the distribution of scores for males and females separately at each grade level.

b. Results

Ninth grade. Table 42 shows the frequency in each request category for the ninth grade experimental program comparisons for pupils classified by instructional treatment, sex and level of mathematics proficiency. At this grade level only one of the comparisons for the three programs revealed a frequency difference that was reliable at the .05 level. A greater proportion of higher proficiency girls in UICSM classes than in the conventional comparison classes made requests for the activity bulletin. For this comparison it was necessary to combine both R-NPO and R-P categories because of the small frequencies.

When comparisons were made for each program with males and females combined, a reliable difference was obtained for higher proficiency pupils in the SMSG program comparison. A greater proportion of those in the conventional classes made requests than those in the SMSG classes. For this comparison, it was possible to partition the 2 x 3 contingency table to determine whether one or both request categories were contributing to the significant χ^2. The difference was found to occur only for the R-NPO category, $\chi^2 = 8.7$, $p < .005$, indicating that for the SMSG program comparison a significantly smaller proportion of E class pupils made non-participation-requests than C class pupils.

Tenth grade. Table 43 shows the request category frequencies for each of the tenth grade experimental program comparisons with pupils classified by sex and proficiency level. With respect to the comparisons within sex by proficiency levels, the only reliable difference was that observed for the UICSM program for high ability boys. A significantly greater proportion of those in the UICSM program made requests for the bulletin than those in the conventional program taught by the same teacher. This result was obtained when R - P and R-NPO categories were combined due to small frequencies in these categories.

TABLE 42

Number of E and C Class Pupils in Each Request Category for Ninth Grade Experimental Program Comparisons

Higher Proficiency

Request Category		Ball State E	Ball State C	Ball State Total	UICSM E	UICSM C	UICSM Total	SMSG E	SMSG C	SMSG Total
Males	N-R	7	5	12	9	6	15	12	8	20
	R{R-NPO	3	9	12	6	3	9	5	9	14
	R{R-P	2	3	5	6	5	11	6	7	13
		12	17	29	21	14	35	23	24	47
Females	N-R	7	8	15	6	7	13	26	11	37
	R{R-NPO	5	5	10	11{8	1{1	12{9 [a]	2	7	9
	R{R-P	5	1	6	3	0	3	9	4	13
		17	14	31	17	8	25	37	22	59
Total	N-R	14	13	27	15	13	28	38	19	57
	R{R-NPO	8	14	22	14	4	18	7	16	23 [b]
	R{R-P	7	4	11	9	5	14	15	11	26
		29	31	60	38	22	60	60	46	106

Lower Proficiency

Request Category		Ball State E	Ball State C	Ball State Total	UICSM E	UICSM C	UICSM Total	SMSG E	SMSG C	SMSG Total
Males	N-R	11	17	28	8	9	17	21	23	44
	R{R-NPO	1	7	8	2	4	6	3	12	15
	R{R-P	0	0	0	1	0	1	3	3	6
		12	24	36	11		24	27	38	65
Females	N-R	11	15	26	4	6	10	19	20	39
	R{R-NPO	4	2	6	3	6	9	6	7	13
	R{R-P	3	0	3	1	3	4	5	7	12
		18	17	35	8	15	23	30	34	64
Total	N-R	22	32	54	12	15	27	40	43	83
	R{R-NPO	5	9	14	5	10	15	9	19	28
	R{R-P	3	0	3	2	3	5	8	10	18
		30	41	71	19	28	47	52	72	129

[a] E-C difference for NR vs. R, p = .02 by Fisher exact probability test.

[b] E-C difference for NR vs. R-NPO, $\chi^2 = 8.7$, $p < .02$.

TABLE 43

Number of E and C Class Pupils in Each Request Category for Tenth Grade Experimental Program Comparisons

Request Category		Ball State E	Ball State C	Ball State Total	UICSM E	UICSM C	UICSM Total	SMSG E	SMSG C	SMSG Total
Higher Proficiency										
Males	N-R	21	22	43	0	5	5	67	69	136
	R{R-NPO	8	3	11	8{4	6{4	14{8 [a]	19	24	43
	R{R-P	6	2	8	4	2	6	15	25	40
		35	27	62	8	11	19	101	118	219
Females	N-R	31	23	54	1	1	2	53	50	103
	R{R-NPO	8	1	9	2	4	6	19	11	30
	R{R-P	3	4	7	2	2	4	23	21	44
		42	28	70	5	7	12	95	82	177
Total	N-R	52	45	97	1	6	7	120	119	239
	R{R-NPO	16	4	20	6	8	14	38	35	73
	R{R-P	9	6	15	6	4	10	38	46	84
		77	55	132	13	18	31	196	200	396
Lower Proficiency										
Males	N-R	18	15	33	8	13	21	65	99	164
	R{R-NPO	4	4	8	8	8	16	15	19	34
	R{R-P	2	5	7	4	1	5	19	13	32
		24	24	48	20	22	42	99	131	230
Females	N-R	20	23	43	2	5	7	55	65	120
	R{R-NPO	3	2	5	4	2	6	20	19	39
	R{R-P	1	0	1	4	1	5	8	7	15
		24	25	49	10	8	18	83	91	174
Total	N-R	38	38	76	10	18	28 [b]	120	164	284
	R{R-NPO	7	6	13	12	10	22	35	38	73
	R{R-P	3	5	8	8	2	10	27	20	47
		48	49	97	30	30	60	182	222	404

[a] E-C difference for NR vs. R, $p = .01$ by Fisher exact probability test.

[b] E-C difference for R-P vs. NR + R-NPO, $\chi^2 = 6.1$, $p < .05$.

When the experimental program comparisons were made combining responses for boys and girls within ability levels, a significant difference was also observed for the lower proficiency pupils in the UICSM comparison. When comparisons were made for each of the specific request categories, a reliably greater proportion of all lower proficiency pupils in the UICSM classes made participation requests than did their conventional class counterparts, $\chi^2 = 6.1$, $p < .05$.

Eleventh grade. Request category frequencies for pupils grouped by sex and ability levels in each of the eleventh grade experimental program comparison conditions are shown in Table 44 . Chi-square tests for each of the E - C comparisons indicate that none of the differences for either of the experimental programs were reliable at the .05 probability level or less.

c. Summary and Discussion

For two of the three programs for which reliable differences were observed (UICSM - 9th grade, higher proficiency girls; UICSM - 10th grade, higher proficiency boys and all lower proficiency pupils) the differences were in favor of the pupils in the respective experimental programs, i.e. the greater proportion of pupils making requests were in the E classes rather than the C classes. For one of these comparisons, UICSM - 10th grade, lower proficiency pupils, the differences occurred only in the R - P category, the category assumed to be indicative of greater interest, there being no difference in proportions in the R-NPO category. For the other two comparisons, UICSM - 9th grade, higher proficiency girls and UICSM - 10th grade, higher proficiency boys, the differences were obtained only when proportions for both request categories were combined - the small frequencies precluding any more exact determination of the nature of the request differences.

The remaining instructional difference, SMSG 9th grade, higher proficiency pupils, favored the conventional program in that there was a smaller proportion of experimental program pupils that made requests. However, this difference was observed only for the R-NPO category, there being no difference in the proportion of pupils that made participant requests.

In connection with these differences it should be recognized that among the number of separate instructional condition comparisons carried out in this study, a certain proportion were likely to reach the level of statistical significance on the basis of chance factors alone.

One factor that might have precluded detecting more extensive differences was the request procedure itself. The procedure did not require an unequivocal reaction at any given point in time. Consequently, it is possible that a variety of interest irrelevant factors such as pupils' misplacing the initial request form or forgetting about the bulletin altogether could have occurred over time. These incidental events may have precluded, in some instances, an indication of even a moderate level of interest that possibly existed for some pupils. This means in effect that the "no request" category probably cannot be considered a very reliable indicator of low or negative interest at least not to

TABLE 44

Number of E and C Class Pupils in Each Request Category for Eleventh Grade Experimental Program Comparisons

Higher Ability

Request Category		Ball State E	Ball State C	Ball State Total	SMSG E	SMSG C	SMSG Total
Males	N-R	53	58	111	33	59	92
	R{R-NPO	21	14	35	12	18	30
	R{R-P	19	14	33	12	9	21
		93	86	179	57	86	143
Females	N-R	37	31	68	24	40	64
	R{R-NPO	13	6	19	8	9	17
	R{R-P	12	12	24	9	12	21
		62	49	111	41	61	102
Total	N-R	90	89	179	57	99	156
	R{R-NPO	34	20	54	20	27	47
	R{R-P	31	26	57	21	21	42
		155	135	290	98	147	245

Lower Ability

Request Category		Ball State E	Ball State C	Ball State Total	SMSG E	SMSG C	SMSG Total
Males	N-R	56	68	124	41	47	88
	R{R-NPO	13	24	37	10	18	28
	R{R-P	8	8	16	5	4	9
		77	100	177	56	69	125
Females	N-R	30	40	70	20	32	52
	R{R-NPO	11	8	19	7	10	17
	R{R-P	1	7	8	3	4	7
		42	55	97	30	46	76
Total	N-R	86	108	194	61	79	140
	R{R-NPO	24	32	56	17	28	45
	R{R-P	9	15	24	8	8	16
		119	155	274	86	115	201

the same extent that the requests indicate some level of positive interest. A related limitation is that the bulletin request procedure provided only for the manifestation of several degrees of positive interest but did provide for any differential indication of negative interest, i.e. it did not distinguish among pupils having anything from neutral to strongly negative attitudes toward mathematics. Both of these limitations reflect the fact that the request procedure established a fairly high response threshold which tended to detect only those with relatively stronger overt response tendencies in addition to a certain degree of positive interest and consequently, to group together (in the "no request" category) pupils with interests ranging from moderately positive to strongly negative. In brief, it did not provide a sensitive differentiation over the entire continuum of interest that might have existed, and also probably reflected an overt activity characteristic in addition to the interest factor.

In general then, the experimental mathematics programs did not, with the possible exception of the UICSM program, exhibit any consistent differential effects relative to conventional programs on pupil interest in mathematics as indicated by the overt participation index of interest used in this study. The limited occurrence of differential effects may have been due in part to the limited sensitivity of this index of interest. For the UICSM program there is some evidence suggesting that it may have contributed to a greater amount of pupil interest in mathematics than the conventional programs taught by the same teachers.

2. <u>Mathematics Student Journal</u>

A separate indication of the participant pupils' inclination toward engaging in activities involving mathematics was obtained by providing the opportunity for pupils to subscribe, at a reduced rate, to a mathematics journal published for high school pupils.

a. <u>Method</u>

The following procedures were carried out for both classes of a subsample of participant teachers - two using the Ball State, three the UICSM and four the SMSG experimental programs in their E classes.[20]

Approximately two months prior to the end of the school semester, several extra copies of recent issues of <u>The Mathematics Student Journal</u>[21] were sent to each teacher in the sample with a request to

[20] This sample was separate from that included in the mathematics activity bulletin study.

[21] Published four times a year by the National Council of Teachers of Mathematics.

circulate the issues among the pupils in their two participating classes. Teachers were told the reason for this was to familiarize pupils with the content and nature of the journal since there was a possibility that pupils might have the opportunity at some subsequent time to subscribe to the journal.

Subsequently, within the questionnaire administered during the last three or four weeks of the semester to all ninth grade classes participating in the project during the 1964-65 school year, a subscription form was included for the classes in this sample. The subscription form indicated that the Mathematics Student Journal could be obtained for only \$ .30 for the year and if the pupil wanted to subscribe he was to check "yes" and put his name and home address in the spaces provided. It was also indicated that the money would be collected at some later date.

The regular individual subscription rate was actually \$ .50 per year, however, there was no intention nor any attempt made to collect the subscription price. This contingency was indicated only to discourage a positive response from pupils who were not really interested in the content but might like to receive a free magazine. All those who indicated a desire to subscribe received all four issues published during the next year.

b. Results

Comparisons were made considering the pupils' initial (entering) level of proficiency in mathematics, as obtained from the mathematics section of the STEP, and the pupils' sex. The proficiency levels were determined by the median of the distribution of test scores for males and females separately.

Table 45 shows the frequency of request for subscriptions to the Mathematics Student Journal for E and C class pupils in each E program comparison condition for each pupil sex and proficiency category. E - C comparisons within and across the latter categories were made using either Chi-square or the Fisher exact probability test. Any differences occurring with a two-tail probability less than .10 are indicated in the table in terms of the results of the statistical test. It can be seen that only in the UICSM comparison, for lower proficiency boys and all boys combined, were there any reliable subscription request frequency differences between E and C class pupils. For this comparison, a higher proportion of the boys in classes instructed with the conventional program than those instructed with the UICSM program made subscription requests. This was true for boys at both levels of proficiency although the difference was greater among those having less proficiency in mathematics.

It might be noted that almost one-fourth (24 percent) of all pupils in these classes having the opportunity to do so requested a subscription to the mathematics journal. Over all classes, a slightly higher proportion of boys (28 percent) than girls (20 percent) gave a positive response. For the boys the proportion of requests were about the same for both levels of proficiency while for the girls the proportion of requests were greater among those having a higher level of proficiency (23 percent) than those having lower proficiency (16 percent).

TABLE 45

Frequency of Requests for Subscription to Mathematics Student Journal for E and C Class Pupils in Each E Program Comparison Condition.

E Program		Ball State						UICSM						SMSG					
Sex		M			F			M			F			M			F		
Instruct. Treat.		E	C	Tot.	E	C	Tot.	E	C	Tot.	E	C	Tot.	E	C	Tot.	E	C	Tot.
Profici. Level	Response[a]																		
Low	RS	2	4	6	1	3	4	3	8	11	3	6	9	5	7	12	1	3	4
	NR	6	9	15	5	4	9	18	9	27	11	17	28	19	13	32	31	17	48
	Total	8	13	21	6	7	13	21	17	38	14	23	37	24	20	44	32	20	52
									$p < 10$[b]										
High	RS	2	4	6	5	4	9	5	6	11	4	6	10	4	9	13	5	1	6
	NR	6	12	18	11	5	16	16	6	22	15	10	25	16	22	38	22	20	42
	Total	8	16	24	16	9	25	21	12	33	19	16	35	20	31	51	27	21	48
Total	RS	4	8	12	6	7	13	8	14	22	7	12	19	9	16	25	6	4	10
	NR	12	21	33	16	9	25	34	15	49	26	27	53	35	35	70	53	37	90
	Total	16	29	45	22	16	38	42	29	71	33	39	72	44	51	95	59	41	100

$\chi^2 = 5.6,\ p < .02$

[a]RS = Requested Subscription

NR = Did Not Request Subscription

[b]Determined by Fisher exact probability test.

c. Summary and Discussion

In this study, the only differential instructional program effect was observed for the UICSM program comparison. Boys instructed with the UICSM program showed a lower frequency of response indicating less frequent interest in obtaining a student mathematics journal than pupils instructed by the same teachers with a conventional program. On the basis of this index of interest in mathematics, it would appear that the UICSM program did not contribute to as high an interest in mathematics as the conventional program.

B. Readership of Library Materials in Mathematics

One of the ways a pupil could satisfy an interest in mathematics would be through reading materials that were concerned with or involved the application of mathematics. This requires that such materials are reasonably available to pupils, that they are written at an appropriate level of comprehension, and that pupils are aware of their availability. Pupil readership of library books dealing with mathematics as an extracurricular activity was used therefore as one behavioral index of interest in mathematics for the purpose of making comparisons between alternate programs of instruction.

It was determined at the outset that in the past few years quite a number of books concerned with mathematics had been written at the level for and with a potential appeal to secondary level pupils. It was also determined, however, that only a small proportion of school libraries had more than a scattering of the recent books or had even a modest collection of any books in this area from which a pupil could choose. Consequently, to establish the minimal conditions necessary to obtain some indication of pupil readership in mathematics, additional library materials were provided for a number of schools having ninth grade mathematics classes participating in the project. Readership of library books on mathematics was then observed under conditions which ensured both availability and the pupils' awareness thereof but which were otherwise quite typical.

1. Method

Sample. The sample in schools receiving additional materials consisted of eleven pairs of ninth grade algebra classes participating in the project which had not been included in the activity bulletin nor the journal subscription studies.[22] Each pair was in a different school and was taught by the same teacher, one class with an E program, the other with the conventional program. Relevant data was also gathered from other participating classes in schools which did not receive any additional materials. The number of pairs of classes in each E program condition are shown in Table 46.

[22]The selection consisted of a random assignment of available class pairs within each E program condition to each of these separate studies.

TABLE 46

Number of Pairs of E and C Classes in Each E Program Condition in Schools Receiving and Not Receiving Supplementary Mathematics Materials

E Program	Receiving Materials	Not Receiving Materials
Ball State	4	7
UICSM	3	6
SMSG	4	11

Procedure. The administrators and librarians in the selected schools were contacted to secure their cooperation with respect to the procedural requirements necessary for the study that are outlined below.

The libraries in these schools were surveyed concerning their holdings with respect to mathematics books and were then supplied with a sufficient number and variety of additional books on mathematics to ensure the availability of a moderately extensive and varied collection. In each library sufficient books were provided so that there was at least 40-50 books available representing approximately 30-40 different titles.

When the books were received by the school, the librarians were requested;

(1) to display all books (new and old) together in a prominent place with the display labeled appropriately,

(2) to allow the books to circulate following the library rules for circulation of all other books,

(3) to make sure all new books had withdrawal cards requiring the name and grade of the pupil withdrawing the book,

(4) to return to the project director at the end of the year the withdrawal cards for all books in the display.

Also upon receipt of the books by the school, the participating teacher was provided with a standard statement to be read to the pupils in each of the two classes which;

(1) announced the availability of the books in the library,

(2) indicated they had been provided through a special project (the nature and purpose of which was not indicated), and

(3) provided a general characterization of the type of books available and the rules governing their circulation.

Teachers were informed as to the general objectives of this study, i.e. determination of the nature of pupil interest, but not the comparative aspect. They were requested neither to encourage nor assign the reading of these materials.

Analysis. Information concerning pupil readership was obtained from two sources; (a) from the names on the withdrawal cards for each book that had been returned at the end of the year from each library and (b) from a set of questions inquiring about mathematics book readership included in a questionnaire administered at the end of the year to all pupils in both the library reading and all other participating classes.

The library cards proved to be a very limited source of information concerning readership of the library materials at least in contrast to the information provided by the questionnaire. For the books in each school, the median number of pupil names per class shown on the withdrawal cards was one. Consequently information from the withdrawal cards was not used in the study as an indication of readership for purposes of comparison.[23]

The most pertinent items in the readership questionnaire (see Appendix G) were those which asked whether the pupil had done any reading in mathematics other than his textbook and requested an indication of the title or content of each book and whether the book(s) had been read completely or only in part. It was also asked whether they had ever sought books on mathematics in the library.

Because the readership items were included in the questionnaires administered to classes in schools not receiving supplementary library materials as well as in those that did, it was also possible to make comparisons to determine readership differences that would be observed for alternate instructional programs under more typical library conditions.

One factor that precluded making observations over a more extended period of time as originally planned was some delay in obtaining the desired books. The materials were not available in the various school libraries until the last three or four months of the school year. Although this factor could not contribute to any differential effect between the E and C programs being compared since there was an E and C class in each school, the generality of the observations for pupils in general might be somewhat limited by this condition. On the other hand, with respect to E - C comparison, it would be expected that any differential effects of the programs would be more likely to occur near the end of the period of instruction. Consequently, the availability of the books and attention being directed to this fact neerer the end of the period of instruction probably contributed to obtaining a more sensitive indication of any differential effects resulting from the instructional programs.

[23] It was not clear why the withdrawal cards failed to reflect the actual amount of reading that was done unless the reading reported in the questionnaire was done mainly in the library precluding the necessity of withdrawing the book.

The comparisons were made considering pupil sex and initial ability level as well as the instructional program. With respect to proficiency level, pupils were classified relative to the median of the scores obtained on the mathematics proficiency test administered at the beginning of the year. Medians were determined separately for each sex, including all pupils in the sample.

2. Results

Table 47 shows for the classes in schools receiving supplementary library books the number of pupils in each instructional treatment (E - C) condition for each E program comparison who reported reading at least part of one book dealing with mathematics in addition to their class texts. Chi-square or the Fisher exact probability test was used to determine the statistical reliability of the instructional program differences within the sex by ability level categories with the results of these tests being shown in Table 43 .

In all participant classes in schools receiving supplementary materials, 16 percent of all pupils indicated they had read some parts of an additional book concerned with mathematics.

For this set of classes, only for the SMSG program comparison was there an E - C difference which was reliable with a probability of .10 or lower. A higher proportion of lower proficiency boys instructed with the SMSG program reported reading additional mathematics materials than similar boys in the comparison conventional classes.

The extracurricular reading reported by E and C class pupils in schools not receiving supplementary materials is shown in Table 48 . Overall, 14 percent of these pupils reported reading part of at least one additional mathematics book. Comparisons between the E and C class pupils in this set of classes indicated that only for the girls in the UICSM program comparison were there any reliable readership differences. Girls instructed with the UICSM program more frequently reported additional reading than those in the comparison conventional classes.

Since the overall readership frequency for pupils in schools receiving and those in schools not receiving supplementary reading materials was very similar (16 and 14 percent, respectively) a more sensitive assessment of E - C differences was obtained by combining both sets of classes within each E program comparison condition. Table 49 shows the E - C readership differences when all participant classes are considered. Only for girls in the UICSM program comparison condition was there a reliable difference in the frequency reporting additional reading in mathematics. A greater proportion of higher proficiency girls instructed with the UICSM program reported additional reading than girls of similar proficiency instructed with the conventional program. No reliable readership differences were indicated for boys instructed with the UICSM program nor for pupils in either of the other E program comparison conditions.

TABLE 47

Frequency With Which E and C Class Pupils Indicated They Had Read at Least Part of One Additional Book on Mathematics in Schools Receiving Supplementary Materials

Proficiency Level	Response	Male E	Male C	Male Total	Female E	Female C	Female Total	Male + Female E	Male + Female C	Male + Female Total
Ball State										
Low	Read	3	6	9	3	2	5	6	8	14
	Not Read	8	18	26	16	18	34	24	36	60
	Total	11	24	35	19	20	39	30	44	74
High	Read	8	8	16	5	2	7	13	10	23
	Not Read	20	20	40	27	17	44	47	37	84
	Total	28	28	56	32	19	51	60	47	107
UICSM										
Low	Read	2	2	4	1	0	1	3	2	5
	Not Read	4	18	22	10	26	36	14	44	58
	Total	6	20	26	11	26	37	17	46	63
High	Read	6	5	11	3	0	3	9	5	14
	Not Read	12	11	23	19	12	31	31	27	58
	Total	18	16	34	22	12	34	40	32	72
SMSG										
Low	Read	6	1	7	1	2	3	7	3	10
	Not Read	12	31	43	27	32	59	59	63	102
	Total	18	32 ($p<.02$)	50	28	34	62	46	66	112
High	Read	10	5	15	3	0	3	13	5	18
	Not Read	22	13	35	23	26	49	45	39	84
	Total	32	18	50	26	26	52	58	44	102

TABLE 48

Frequency With Which E and C Class Pupils Indicated They Had Read At Least Part of One Additional Book on Mathematics in Schools Not Receiving Supplementary Materials

Proficiency Level	Response	Male E	Male C	Male Total	Female E	Female C	Female Total	Male + Female E	Male + Female C	Male + Female Total
Ball State										
Low	Read	2	7	9	5	3	8	7	10	17
	Not Read	30	41	71	42	36	78	72	77	149
	Total	32	48	80	47	39	86	79	87	166
High	Read	6	4	10	3	0	3	9	4	13
	Not Read	24	40	64	39	29	68	63	69	132
	Total	30	44	74	42	29	71	72	75	145
UICSM										
Low	Read	3	7	10	2	1	3	5	8	13
	Not Read	39	33	72	29	43	72	68	76	144
	Total	42	40	82	31	44	75	73	84	157
High	Read	10	8	18	6	0	6	16	8	24
	Not Read	38	24	62	33	26	59	71	50	121
	Total	48	32	80	39	26	65	87	58	145
					$.05<p<.10$					
SMSG										
Low	Read	8	13	21	7	12	19	15	25	40
	Not Read	68	84	152	92	78	170	160	162	322
	Total	76	97	173	99	90	189	175	187	362
High	Read	15	25	40	17	12	29	32	37	69
	Not Read	52	46	98	70	46	116	122	92	214
	Total	67	71	138	87	58	145	154	129	283

TABLE 49

Frequency With Which E and C Class Pupils In <u>All</u> Participating Classes Indicated They Had Read at Least Part of One Additional Book on Mathematics

Proficiency Level	Response	Male E	Male C	Male Total	Female E	Female C	Female Total	Male + Female E	Male + Female C	Male + Female Total
Ball State										
	Read	5	13	18	8	5	13	13	18	31
Low	Not Read	38	59	97	58	54	112	96	113	209
	Total	43	72	115	66	59	125	109	131	240
	Read	14	12	26	8	2	10	22	14	36
High	Not Read	44	60	104	66	46	112	110	106	216
	Total	58	72	130	74	48	122	132	120	252
UICSM										
	Read	5	9	14	3	1	4	8	10	18
Low	Not Read	43	51	94	39	69	108	82	120	202
	Total	48	60	108	42	70	112	90	130	220
	Read	16	13	29	9	0	9	25	13	38
High	Not Read	50	35	85	52	38	90	102	77	179
	Total	66	48	114	61	38	99	127	90	217
						$p<.03$				
SMSG										
	Read	14	14	28	8	14	22	22	28	50
Low	Not Read	80	115	195	119	110	229	219	225	444
	Total	94	129	223	127	124	251	241	253	494
	Read	25	30	55	20	12	32	45	42	87
High	Not Read	74	59	133	93	72	165	167	131	298
	Total	99	89	188	113	84	197	212	173	385

To determine the validity of the pupils' response to the direct inquiry concerning additional reading in mathematics, they were also asked to give the title or a description of each of the books they had read completely or in part. Considering pupils in all classes completing the questionnaire, 95 percent of those who indicated that they had read some additional material were able to provide one or more titles or descriptions of the book or books they read. There were no differences in this respect between E or C class pupils, nor between those in schools which had and had not received supplementary materials. The accuracy of the titles and descriptions given in addition to their frequency indicated quite clearly that pupils who stated that they had done some additional reading in mathematics did in fact do so. In fact, considering the possibility of pupils forgetting titles, etc., of what they may have read over a period of time, this figure suggests that the more general statement of readership may have underestimated the actual number of pupils who had in fact done some reading.

To determine whether the program of instruction in mathematics may have affected the amount of additional reading in mathematics (i.e. number of books read) among pupils who reported having done some reading, E - C comparisons were made with respect to the number of books individual pupil's reported reading. These comparisons were made in terms of the number of pupils' giving titles or descriptions of two or more books and those giving less than two. (The small proportion giving no titles were included in the latter category.) Since the results of these comparisons within each E program condition were essentially the same for pupils in schools receiving and not receiving supplementary materials, the results of this comparison are shown with both sets of classes combined in Table 50 . Overall, somewhat more than half (54 percent) of the pupils who reported doing some additional reading were able to list two or more titles or descriptions. However, there were no significant differences in this respect between E and C class pupils within or across any of the sex by proficiency level categories for any of the E program comparison conditions. One limitation of this index was the small frequencies for some of the comparisons which made it difficult to detect smaller differences.

Although readership of books about mathematics is usually preceded by looking in the library for such materials, the latter does not necessarily lead to the former. The alternate programs of instruction may have had differential effects on pupils' inclinations to seek reading materials in mathematics which may not have been reflected in actual readership due to a number of factors. One such factor may have been the unavailability of materials that seemed reasonably appropriate or of sufficient interest from the pupil's point of view to engage further in the activity. To determine therefore, whether a weaker manifestation of interest in reading in the mathematics area may have occurred differentially between the alternate instructional programs, especially for pupils in schools not receiving supplementary materials, pupils were asked whether they ever had looked for books about mathematics in their library.

TABLE 50

Number of Titles or Descriptions Given by Pupils in All Classes Who Reported Reading Materials in Mathematics

Proficiency Level	Number of Titles	Male E	Male C	Male Total	Female E	Female C	Female Total	Male + Female E	Male + Female C	Male + Female Total
Ball State										
	1	3	9	12	4	3	7	7	12	19
Low	2+	2	4	6	4	2	6	6	6	12
	Total	5	13	18	8	5	13	13	18	31
	1	7	3	10	4	1	5	11	4	15
High	2+	7	9	16	4	1	5	11	10	21
	Total	14	12	26	8	2	10	22	14	36
UICSM										
	1	2	2	4	0	1	1	2	3	5
Low	2+	3	7	10	3	0	3	6	7	13
	Total	5	9	14	3	1	4	8	10	18
	1	7	4	11	4	0	4	11	4	15
High	2+	9	9	18	5	0	5	14	9	23
	Total	16	13	29	9	0	9	25	13	38
SMSG										
	1	7	4	11	4	7	11	11	11	22
Low	2+	7	10	17	4	7	11	11	17	28
	Total	14	14	28	8	14	22	22	28	50
	1	11	15	26	10	7	17	21	22	43
High	2+	14	15	29	10	5	15	24	20	44
	Total	25	30	55	20	12	32	45	42	87

For the set of classes in schools not receiving supplementary materials, 22 percent of all of the pupils indicated that sometime during the year they had looked for books about mathematics in the library. Comparisons within and across sex by proficiency level categories revealed no reliable ($p < .10$) differences in this regard between E and C class pupils in any of the E program comparison conditions.

For the set of classes in schools receiving supplementary materials (with a special display and an announcement emphasizing the display and the availability of books), 38 percent of the pupils reported looking for materials. For this set of classes, no reliable differences were observed within or across the sex by proficiency level categories for any of the E program comparisons. It did not appear then that the programs elicited any differential tendency to examine the reading materials available in the area of mathematics.

3. Summary and Discussion

The results indicated that a somewhat greater proportion of lower proficiency boys instructed with SMSG materials and higher proficiency girls instructed with UICSM materials engaged in extracurricular reading in mathematics than similar pupils instructed with conventional materials. In the former case, the difference occurred only for classes for whom supplementary materials were available. The UICSM difference appeared to be independent of the availability of materials and consequently would appear to represent a more general effect. On the other hand, for none of the programs did the differences occur across both sexes or levels of initial proficiency indicating that the specific program effects were not too pervasive.

Although providing the library materials and making pupils aware of their availability increased the frequency with which pupils looked for and examined books in this area, it appears that only a relatively small proportion of pupils went much further than this and engaged in any amount of actual reading. Consequently in each case where a difference was observed in this regard, the difference only involved a small number of pupils.

Among those who did report doing some reading, no additional differences associated with the programs were found with respect to the amount of individual reading reported in terms of the number of books read per individual pupil.

One point that is of interest to note is that a much larger proportion of boys in all programs reported reading in mathematics than girls and that this difference varied with the availability of the materials - boys taking more advantage of their availability. In this regard, the proportions of boys and girls who read at least part of one book in mathematics were, respectively 25 and 8 percent in classes receiving additional materials.

C. Subsequent Enrollment in Advanced Mathematics and Science

1. Study I

The purpose of the study was to determine whether the experimental programs had a differential effect on pupils' enrollment decisions in subsequent years with respect to mathematics and related subjects.

Among the overt behavioral indications that a pupil could exhibit in the school situation that would represent an interest in a given subject matter area would be to choose to enroll in courses involving that subject when a choice is permitted. This is especially possible for mathematics since there is in most schools an advanced mathematics course at each grade level in high school in which the pupil can choose to enroll or not as he desires. One indication therefore, of the effects of alternate instructional programs on pupil attitudes toward mathematics in the ninth grade would be obtained from the enrollment in mathematics subjects during the subsequent years in high school on the part of pupils instructed with the different programs. Other things being equal, pupils instructed with programs contributing to a more positive attitude toward mathematics would be more likely to enroll in mathematics subjects during the next and possibly the following years.

There are, of course, a number of factors of an extrinsic nature other than intrinsic interest per se that influence or determine the subject choices pupils make in high school. Future educational plans and related requirements are no doubt predominant in such decisions with parents and teachers playing an influential role therein, usually encourageing enrollment. Nonetheless, there is no doubt a certain number of instances in which the extrinsic factors in both directions are about equally balanced for a pupil and his own attitudes and interests operate to determine the choice or resolve the decision. Because, for higher ability pupils the extrinsic factors would tend to be more heavily weighted toward enrollment, these instances would seem more likely to occur for pupils having somewhat lower mathematics proficiency or general academic ability. Presuming therefore, a reasonably equal or random distribution of pupils with respect to other influencing factors among alternate instructional programs, differences between them in proportion of pupils enrolling in subsequent mathematics subjects could be attributed to the effects of the program on the pupils' interest in mathematics.

Following the same reasoning, the level of a pupil's interest in mathematics might also influence his attitudes toward and enrollment decisions concerning other subjects in which mathematics is applied or which are concerned with quantitative concepts and relationships. Science subjects for the most part would seem to be in this category.

The main question for this study concerned the differences in enrollment in tenth and eleventh grade advanced mathematics and science courses between pupils previously instructed with one of the three experimental programs and those instructed, respectively, with the conventional program being used by the same teachers.

Two other factors relevant to enrollment in advanced mathematics were considered in the analysis, the grades the pupil earned in ninth grade mathematics and the pupil's sex. Probably the factor that most determines future enrollment in mathematics is the pupil's level of achievement as represented by the grades received in his last mathematics class. Also, as indicated above, an enrollment difference is more likely to be observed among lower than higher achieving pupils. In addition to individual differences in achievement, sex differences are also likely to occur with respect to enrollment in more advanced mathematics classes. Previous studies have observed sex differences with respect to the nature of educational goals, objectives, and aspirations of pupils as well as in attitudes toward mathematics . Consequently both pupil sex and ninth grade mathematics performance (grades) were taken into account.

a. Method

During the 1962-63 school year, as part of the larger project assessing achievement differences for the several experimental secondary mathematics programs, pupils in a number of schools were enrolled in ninth grade algebra classes in which either one of the three experimental (E) or a conventional (C) program was being used in alternate classes taught by the same teacher. During the 1964-65 school year, these schools were contacted with a request for grade and enrollment information for the pupils that had been instructed in the E and C classes two years previously. Information was requested concerning pupil enrollment and final subject grades during the ninth and tenth grades and for enrollment during the eleventh grade. (Pupils had not completed eleventh grade at the time the data was gathered). Enrollment and grade information was obtained for each of the following subject matter areas: mathematics, language arts (English or literature), social studies and science.

This information was requested from the schools for 32 pairs of classes - one experimental and one conventional class being in each school. The number of pairs of classes (and the number of teachers) in each of the experimental program conditions for which information was requested and the number for which usable information was obtained for both classes is shown in Table 51 .[24]

TABLE 51

Number of Pairs of E and C Classes for Whom Enrollment and Grade Data Was Requested and Included in the Analysis for Each E Program Comparison Condition

E Program	Requested	Included
Ball State	9	7
UICSM	11	5
SMSG	12	9
Total	32	21

[24] Some schools did not respond to the request, others were only able to provide limited information concerning subsequent enrollment and grades.

During each of the two years following the ninth grade, a pupil could choose to enroll in none, one, or two additional mathematics subjects. Furthermore, among those enrolling in one additional mathematics subject over the two years, it was possible to do so either in the tenth or eleventh grades. For purposes of this study the distinction between enrollment in the tenth or the eleventh grade is of some relevance since in general, any differential effects of ninth grade instructional conditions on attitudes toward mathematics would most likely be reflected in enrollment decisions made for the tenth grade rather than for higher grades. Enrolling in an additional mathematics subject at the next opportunity rather than doing so after a year's delay would seem to be in itself one indication of a possible attitude difference developed during the immediately preceding year.

Therefore, comparisons with respect to enrollment in tenth grade mathematics subjects independent of the eleventh grade enrollment, appeared to provide the most sensitive and direct indication of pupil attitudes as manifested in enrollment decisions subsequent to the ninth grade and consequently, the comparison most relevant to this question. Separate comparisons considering eleventh grade enrollment were also made however to determine the more general enrollment effects of the ninth grade instructional programs.

With respect to enrollment in advanced mathematics in the tenth or eleventh grades, either geometry, advanced or higher algebra, trigonometry or solid geometry were considered as advanced mathematics subjects. Neither re-enrollment in elementary algebra (due to previous failure) nor general or commercial mathematics were considered advanced mathematics subjects.

To take ninth grade performance into account, the overall distribution of grades for all pupils was determined. An A, B vs C, D division was closest to the median and served as the basis for classifying pupils with respect to level of performance for analysis purposes. Similarly, to control for and assess possible sex differences, the comparisons were made separately for males and females within the alternate performance levels and instructional treatment (i.e. E or C) classifications. In the analysis pupils in the respective E and C classes for teachers following the same E program were combined to provide separate comparisons for each of the three experimental program conditions.

With respect to science subjects, enrollment and grade comparisons were made only for the tenth grade. It was felt that it would be quite unlikely that ninth grade mathematics would have an effect on enrollment in eleventh grade science subjects because of the even larger number of intervening factors than would be the case for mathematics. The subjects treated as science subjects were general, physical or biological science, physics, biology and chemistry.

b. Results

i. Enrollment in tenth grade mathematics

Table 52 shows the tenth grade mathematics enrollment frequencies for E and C class pupils in each E program comparison condition. The reliability of the E - C enrollment differences (i.e. the probability that the differences were due to chance) within each performance level for the sexes separately and combined was determined using χ^2 or the Fisher exact probability test.

Among pupils who had performed or achieved at a relatively higher level in the ninth grade (grades of B or better), a very large proportion continued to enroll in mathematics subjects in the tenth grade. This tendency appeared equally strong for pupils in E and C classes in each of the E program comparison conditions. Among pupils who had performed or achieved at a relatively lower level in the ninth grade (grades of C or D), a greater proportion of the E class boys in the Ball State and UICSM programs and E class girls in the UICSM and SMSG programs tended to enroll in tenth grade mathematics than did their respective C class counterparts. For the Ball State and UICSM boys, the frequency differences were highly reliable while neither of the E program comparisons for the girls reached the .05 level of significance. Comparisons made with both sexes combined also showed that among lower performing pupils a significantly higher proportion of those in the E classes enrolled for both the Ball State and UICSM programs. It is evident, however, that the difference for the Ball State program is due only to the large difference in this regard for boys rather than girls while for the UICSM comparison both sexes contributed to the difference. It appears then that a greater proportion of boys instructed with the Ball State program and of both sexes instructed with the UICSM program enrolled in tenth grade mathematics subjects than did comparable pupils instructed with conventional programs.

Independent of the pupils relative performance level, other factors possibly relevant to enrollment in tenth grade mathematics could have differed between E and C class pupils and thereby contributed to the enrollment differences. It is possible that in the E classes there was a greater proportion of pupils having higher ability or proficiency in mathematics, higher general academic ability, and/or a more positive attitude toward mathematics or toward academic achievement generally. A difference in favor of the E classes with respect to any or all of these factors (which tend to be related) may have occurred either accidentally or even to some extent intentionally or systematically. The latter possibility seems quite likely because of the characterization of the experimental or "modern" programs as being primarily for "college-bound" pupils. For this as well as other reasons, there may have been a greater tendency to shunt "less promising" pupils (as inferred from previous mathematics class or general academic performance) into the conventional classes. These factors could operate independent of the performance measure (grades) if teachers were assigning grades within classes on a relative rather than a more absolute performance basis.

TABLE 52

Enrollment in Tenth Grade Mathematics Subjects for Pupils in E and C Classes for Each E Program Comparison Condition.

E Program	BALL STATE						UICSM						SMSG					
Ninth Grade Math Performance Level	Low			High			Low			High			Low			High		
Instructional Treatment	E	C		E	C		E	C		E	C		E	C		E	C	
Males																		
Enrolled	28	15	43	30	35	65	31	17	48	25	18	43	37	39	76	53	61	114
Not Enrolled	8	24	32	2	5	7	7	17	24	2	3	5	19	23	42	0	3	3
	36	39	75	32	40	72	38	34	72	27	21	48	56	62	118	53	64	117
	$\chi^2 = 10.3$[a]			$p = .33$[b]			$\chi^2 = 6.69$			$p = .40$			$\chi^2 = .03$			$p = .16$		
	$p < .01$						$p < .01$						$p < .90$					
Females																		
Enrolled	17	12	29	36	31	67	24	16	40	28	24	52	31	22	53	70	52	122
Not Enrolled	14	12	26	12	6	18	6	14	20	5	3	8	19	27	46	11	12	23
	31	24	55	48	37	85	30	30	60	33	27	60	50	49	99	81	64	145
	$\chi^2 = .01$			$\chi^2 = .51$			$\chi^2 = 3.68$			$p = .25$			$\chi^2 = 2.26$			$\chi^2 = .38$		
	$p > .90$			$p < .50$			$p < .10$						$p < .20$			$p < .60$		
All Pupils																		
Enrolled	45	27	72	66	66	132	55	33	88	53	42	95	68	61	129	123	113	236
Not Enrolled	22	36	58	14	11	25	13	31	44	7	6	13	38	50	88	11	15	26
	67	63	130	80	77	157	68	64	132	60	48	108	106	111	217	134	128	262
	$\chi^2 = 6.81$			$\chi^2 = .11$			$\chi^2 = 11.47$			$\chi^2 = .03$			$\chi^2 = 1.54$			$\chi^2 = .55$		
	$p < .01$			$p < .80$			$p < .001$			$p < .90$			$p < .30$			$p < .50$		

[a] χ^2 computed with Yates correction.

[b] Probability values are the exact probability of an E - C difference as large or larger than obtained.

Data was not available to examine the question concerning the pupils general academic ability nor his attitudes or motivation to achieve either in mathematics in particular or in school generally. However, if proficiency differences did exist between pupils in E and C classes independent of the grades received, these differences should have been reflected on a proficiency test measure (mathematics section, STEP) obtained for a large proportion of these pupils at the beginning of the ninth grade. Here again this question is only of consequence for pupils in the lower ninth grade performance level, since it was only for pupils in this category that there was a reasonable nonenrollment proportion to provide a basis for comparison. Within each E program comparison condition for lower performance pupils, enrollment comparisons were made separately for those above and below the median on the proficiency test as obtained for the males and females separately. Table 53 shows these frequencies.

Two points are evident in the Ball State and UICSM comparisons. One is that there was a greater proportion of relatively higher proficiency pupils in the E than in the C classes. Comparisons between the proportions of E and C class pupils above and below the test median, shown as marginal totals, indicates that the differences in this respect for the Ball State males ($\chi^2 = 6.8$, $p < .01$) and females ($\chi^2 = 4.2$, $p < .05$) and for the UICSM pupils (both sexes combined, $\chi^2 = 3.8$, $.05 < p < .10$) were quite reliable.

It is also apparent that even within the proficiency levels a greater proportion of the Ball State boys and UICSM boys and girls enrolled in tenth grade mathematics subjects. This tendency was stronger for those in the below median category, although for none of these comparisons did the difference reach the .05 level of significance.

For the SMSG program comparison, there was no difference between the E - C classes with respect to test proficiency however, among the higher proficiency girls, a somewhat greater proportion of those in the SMSG program enrolled in tenth grade mathematics.

In general, it appears that the enrollment differences observed for the Ball State boys and for all UICSM pupils were due in part but not totally to existing differences in mathematics proficiency as indicated by test scores. Apparently for the E - C class pairs in the Ball State and UICSM comparisons, the E class pupils had on the average a somewhat higher level of proficiency which was not, however, reflected on the grades they had received.

ii. Enrollment in tenth and eleventh grade mathematics

Considering tenth and eleventh grade mathematics subjects, there were several alternate enrollment sequences after the ninth grade:

a) no further enrollment in tenth and eleventh grades

b) enrollment in eleventh grade only

c) enrollment in tenth grade only

d) enrollment in both tenth and eleventh grade

TABLE 53

Tenth Grade Mathematics Enrollment Frequencies for Low Ninth Grade Performance Pupils in E and C Classes Within Levels of Mathematics Test Proficiency.[a]

Test level	Below median						Above median					
Sex	M			F			M			F		
Program	E	C		E	C		E	C		E	C	
Ball State:												
Enrolled	6	7	13	5	6	11	17	7	24	7	2	9
Not enrolled	2	13	15	8	10	18	4	4	8	6	1	7
	8	20	28	13	16	29	21	11	32	13	3	16
	$p = .07$			$p > .10$			$p > .10$			$p > .10$		
UICSM:												
Enrolled	8	7	15	7	6	13	14	5	19	9	4	13
Not enrolled	7	12	19	2	6	8	0	2	2	4	3	7
	15	19	34	9	12	21	14	7	21	13	7	20
	$p > .10$			$p > .10$			$p > .10$			$p > .10$		
SMSG:												
Enrolled	15	13	28	13	11	24	20	19	39	18	6	24
Not enrolled	10	13	23	12	15	27	9	9	18	7	9	16
	25	26	51	25	26	51	29	28	57	25	15	40
	$p > .10$			$p > .10$			$p > .10$			$\chi^2 = 3.42$ $.05 < p < .10$		

[a] The frequencies shown in this table do not match those in the previous table due to test data being unavailable for some pupils.

Enrollment in additional mathematics courses beyond the tenth grade (categories [c] and [d] above), however, is no doubt influenced at least as much by the pupils' experience in his tenth grade class as his experience in ninth grade. Consequently, E - C comparisons with respect to categories (a) and (b) would appear to provide a more meaningful reflection of the effects of the ninth grade program and therefore, eleventh grade enrollment comparisons were made separately for those who did and did not enroll in mathematics in the tenth grade, i.e. for those in categories (c) and (d) and those in categories (a) and (b), respectively. Since in the previous analysis the mathematics test scores appeared to provide a more sensitive control for existing differences in relevant pupil characteristics, the eleventh grade enrollment comparisons were made within levels of performance on the test measure of proficiency in mathematics obtained at the end of the ninth grade rather than the pupils' grades.

This analysis also permitted another comparison with respect to E - C differences in tenth grade enrollment, i.e. a comparison involving the proportions in categories a + b and c + d . This comparison was analogous to that carried out for the lower ninth grade performance pupils except that it included pupils at both performance levels and the post proficiency test was used to provide a somewhat tighter control on proficiency differences.

Advanced mathematics enrollment frequencies for males and females above and below the median of the distribution of the proficiency test scores for each of the possible enrollment sequences are shown in Table 54 . (This table includes only those for whom actual enrollment decisions at both the tenth and eleventh grades were known, i.e., those who remained in the school system from the ninth grade into the eleventh grade.) Comparisons between the enrollment frequencies for E and C class pupils were made within sex by proficiency level categories using either Chi-square or the Fisher exact probability test.

For pupils who had not enrolled in tenth grade mathematics, only one difference was reliable with a statistical probability of .10 or less. Higher proficiency girls who had been instructed with the SMSG program showed a significantly lower ($p < .03$) frequency of eleventh grade enrollment than comparable girls instructed with the conventional program. There were no similar tendencies indicated at the eleventh grade level for other pupils instructed with the SMSG program nor was this tendency observed for SMSG pupils for tenth grade enrollment.

Among pupils who had enrolled in tenth grade mathematics, the only E - C difference in eleventh grade enrollment reaching the .10 level of probability was that for the lower proficiency UICSM boys ($p < .08$) who had a higher frequency of enrollment relative to those in the conventional comparison classes. The latter difference appears to be a continuation of a tendency observed at the tenth grade level.

TABLE 54

Frequency of Enrollment in Tenth and Eleventh Grade Mathematics Subjects for E and C Class Pupils Within Post Ninth Grade Mathematics Test Proficiency Levels

Test level		Below median				Above median			
Sex		M		F		M		F	
Program		E	C	E	C	E	C	E	C
Grade enrolled									
Ball State	9 only	1	12	10	10	0	2	1	1
	9 & 11	3	6	4	3	3	4	7	2
	Total-not 10	4	18	17	13	3	6	8	3
	9 & 10	5	2	9	6	12	12	8	10
	9, 10, & 11	9	7	10	3	26	17	13	13
	Total - 10	14	9	19	9	38	29	21	23
UICSM	9 only	7	12	7	8	0	1	2	3
	9 & 11	0	3	4	3	1	3	0	0
	Total-not 10	7	15	11	11	1	4	2	3
	9 & 10	9	10	15	15	8	6	11	12
	9, 10, & 11	9	2	5	3	26	14	14	9
	Total - 10	18	12	20	18	34	20	25	21
SMSG	9 only	8	13	14	23	6	6	8	3
	9 & 11	1	0	0	3	0	0	1	6
	Total-not 10	9	13	14	26	6	6	9	9
	9 & 10	9	10	18	15	6	7	14	9
	9, 10, & 11	16	16	18	15	37	30	29	13
	Total - 10	25	26	36	30	43	37	43	22

In general, there was little evidence that eleventh grade mathematics enrollment decisions were influenced to any real extent by the specific program of instruction at the ninth grade level when comparisons were made considering pupil proficiency in mathematics. The only exception was for the girls instructed with the SMSG program. However, in view of the lack of similar differences for other comparisons for the SMSG program these results appear to be too specific to provide the basis for any broad generalization in this regard.

Further comparisons made with respect to enrollment in tenth grade when post proficiency level was considered as shown in Table 54, indicated a greater enrollment proportion for lower proficiency boys instructed with the Ball State, $\chi^2 = 6.85$, $p < .01$, and the UICSM, $\chi^2 = 2.99$, $.05 < p < .10$, programs. Although there was no direct control for ninth grade performance level in the latter comparisons, examination of Table 54 suggests that such a control may not have been necessary since there were no real differences in the proportions of high and low performance pupils between the E and C class pupils being compared. Consequently when the analysis considered a larger sample of pupils (i.e. both performance levels) with a control for proficiency differences, the tenth grade mathematics enrollment proportions for lower proficiency Ball State boys were clearly higher than those for similar conventional class pupils. A similar difference which was not of the same magnitude was also observed for the lower proficiency UICSM boys.

Taken altogether the observed program differences suggest that the Ball State and possibly the UICSM programs were having some effect on subsequent enrollment decisions at least for pupils for whom such a choice would seem to represent more of an option.

iii. Enrollment in tenth grade science

To determine if the instructional program followed in ninth grade algebra may have influenced enrollment decisions for subjects other than mathematics which were likely to utilize mathematics or to involve quantitative concepts and relations, comparisons were made between E and C class pupils with respect to enrollment in science subjects in the tenth grade.

To control for the possible effects of grades received in previous science subjects, comparisons were made separately for pupils who had received a grade of B or better and C or less in their ninth grade science subjects.

Table 55 shows the tenth grade science enrollment frequencies for the sexes separately within the two levels of ninth grade science performance. Either Chi-square or the exact probability test was used to determine the reliability of the E - C differences in enrollment frequencies.

TABLE 55

Enrollment in Tenth Grade Science Subjects for Pupils in E and C Classes for Each E Program Comparison Condition

E Program	BALL STATE						UICSM						SMSG					
9th Grade Science Performance Level	Low			High			Low			High			Low			High		
Instructional Treatment	E	C		E	C		E	C		E	C		E	C		E	C	
Males																		
Enrolled	19	25	44	27	14	41	17	28	45	32	23	55	37	46	83	49	49	98
Not enrolled	6	8	14	8	13	21	11	4	15	4	0	4	7	5	12	4	8	12
	25	33	58	35	27	62	28	32	60	36	23	59	44	51	95	53	57	110
	$\chi^2 = .08$[a]			$\chi^2 = 3.30$			$\chi^2 = 4.38$			$p = .15$[b]			$\chi^2 = .34$			$\chi^2 = .62$		
	$p > .70$			$.05 < p < .10$			$p < .05$						$p > .50$			$p > .40$		
Females																		
Enrolled	16	13	29	32	21	53	23	24	47	30	25	55	36	30	66	56	45	101
Not enrolled	4	7	11	9	5	14	2	7	9	9	0	9	4	8	12	10	4	14
	20	20	40	41	26	67	25	31	56	39	25	64	40	38	78	66	49	115
	$\chi^2 = .50$			$\chi^2 = 0$			$p = .14$			$p < .01$			$\chi^2 = 1.08$			$\chi^2 = .71$		
	$p > .40$			$p > .95$									$.20 < p < .30$			$p > .30$		
All Pupils																		
Enrolled	35	38	73	59	35	94	40	52	92	62	48	110	73	76	149	105	94	199
Not enrolled	10	15	25	17	18	35	13	11	24	13	0	13	11	13	24	14	12	26
	45	53	98	76	53	129	53	63	116	75	48	123	84	89	173	119	106	225
	$\chi^2 = .21$			$\chi^2 = 1.58$			$\chi^2 = .50$			$p = .001$			$\chi^2 = 0$			$\chi^2 = .01$		
	$p > .60$			$.20 < p < .30$			$p > .40$						$p > .95$			$p > .90$		

[a] χ^2 computed with Yates correction.

[b] Probability values are the exact probability of an E - C difference as large or larger than obtained.

For the Ball State and SMSG program comparisons, none of the E - C enrollment differences reached the .05 level of probability. For the UICSM program, however, lower ninth grade performance boys and higher performance girls (and both sexes combined) showed a reliably lower frequency of enrollment than conventional class pupils.[25]

The differential enrollment in tenth grade science observed for the UICSM pupils would suggest that this program may have had a deterring effect on pupil decisions in this regard. However, this difference was not consistent with the relatively higher frequency of enrollment in tenth grade mathematics for the UICSM pupils which would seem to be a more sensitive indicator of attitudinal effects of the program on enrollment decisions with respect to subjects involving mathematics. One possibility was that the two decisions were not independent, that for some pupils the decision to enroll in mathematics affected the decision not to enroll in science or vice-versa. That is, a certain proportion of pupils may have decided not to enroll in both mathematics and science subjects but rather to select one or the other. If a relatively higher proportion of such pupils in the UICSM classes chose to enroll in mathematics then a relatively smaller proportion would have enrolled in science which would account for the observed differences. To determine if this were the case, a tabulation was made considering the tenth grade enrollment in both mathematics and science jointly, disregarding previous performance. This tabulation is shown in Table 56 .

TABLE 56

Frequency of Enrollment in Tenth Grade Mathematics and Science for Pupils Instructed with the UICSM and Conventional Programs

		Science					
		E			C		
Mathematics		Not Enrolled	Enrolled		Not Enrolled	Enrolled	
MALES	Not Enrolled	3	4	7	3	17	20
	Enrolled	12	46	58	1	34	35
		15	50	65	4	51	55
FEMALES	Not Enrolled	1	10	11	3	13	16
	Enrolled	10	43	53	4	36	40
		11	53	64	7	49	56

[25]Comparisons made within the SMSG and Ball State programs for the small number of pupils not enrolled in ninth grade science also showed no differences. Only a very small number of pupils in the UICSM comparison were not enrolled in ninth grade science.

It is apparent that the tenth grade mathematics and science enrollment differences between UICSM and C class pupils occured almost completely among pupils who enrolled in only one of these two subjects. Among pupils enrolled in either mathematics or science, those from the UICSM classes were more likely to enroll in mathematics and those from the C class to enroll in science. Considering just the pupils who enrolled in only one of the two subjects, the degree of association between subject chosen (mathematics or science) and program of instruction (UICSM or conventional) was highly reliable, $\chi^2 = 14.6$, $p < .001$. However, a comparison between the proportion of UICSM and C class pupils enrolled in both subjects indicated that these differences were not reliable either for boys, $\chi^2 = .61$, $p > .40$, or girls, $\chi^2 = .04$, $p > .80$.

Consequently it appears that the differential frequency of tenth grade science enrollment observed in the UICSM comparison occurred only among pupils selecting either mathematics or science and was a result of this differential choice. UICSM pupils more frequently chose mathematics, conventional class pupils more frequently chose science. It seems most reasonable to conclude that for pupils in the UICSM comparison the tenth grade mathematics and science enrollment differences were mainly a result of the ninth grade mathematics program directly affecting the mathematics enrollment decision and thereby affecting the science decision indirectly. That is, the decision with respect to science enrollment followed from the mathematics enrollment decision which was affected by the ninth grade mathematics program.

c. Summary and Discussion

With respect to the effects of the program of instruction in ninth grade mathematics on decisions to enroll in advanced mathematics in the tenth grade, a greater frequency of enrollment was observed among lower ninth grade performance boys instructed with the Ball State program and lower performance boys and girls instructed with the UICSM program when compared to similar pupils in conventional classes taught by the same teachers. No differences in enrollment between E and C class pupils for any of the E programs were observed for higher performance ninth grade pupils, a very large majority of whom enrolled in tenth grade mathematics. There were also no consistent instructional program differences in advanced mathematics enrollment at the eleventh grade level either for those who had or had not enrolled in tenth grade mathematics. The one difference that was observed (a lower enrollment for higher proficiency girls instructed with the SMSG program who had not enrolled in tenth grade mathematics) would seem more likely to be a result of factors other than the attitudinal effects of the ninth grade program since similar differences were not observed for other SMSG program enrollment comparisons that should have been more sensitive to such attitudinal effects. The results obtained for eleventh grade enrollment do not suggest that there were any extensive effects of the ninth grade programs on subsequent enrollment decisions beyond the tenth grade level.

Although the pupils for whom tenth grade enrollment differences were observed (lower performance E and C class pupils in the Ball State and UICSM comparison condition) did not differ with respect to the grades they received in their ninth grade mathematics classes, the E class pupils that exhibited a higher frequency of enrollment were found to have a higher initial level of proficiency as indicated by mathematics test scores. The analysis indicated that this difference could account for some of the enrollment differential. Even though it does not seem likely that the proficiency test scores in themselves would have directly affected the pupils' enrollment decisions in the same way for example that his grades might do so, scores on similar tests may have been used within the school as a basis for recommendations concerning subsequent enrollment, especially for lower performance pupils. Another possibility is that the test scores were reflecting a somewhat higher general academic ability among the E class pupils which in turn would be more likely to be associated with subsequent enrollment in academic subjects. Nonetheless,comparisons in which proficiency differences were controlled continued to show a somewhat higher enrollment for lower proficiency boys instructed with the UICSM and Ball State programs; the differences for the latter being larger and more reliable. For the UICSM pupils, it was also found that the relatively higher enrollment in mathematics was related to a significantly lower enrollment in tenth grade science subjects. For both mathematics and science subjects the more general enrollment differences were found to be mainly the result of differences in this regard between UICSM and C class pupils who had enrolled in only one of the two subjects, those in the UICSM program tending to enroll in mathematics, those in the conventional program in science. Comparisons for the other experimental programs did not indicate any tenth grade science enrollment differences. Consequently it appears that any affects of the experimental mathematics programs on science enrollment may have been only an indirect result of experimental program effects on mathematics enrollment decisions.

There is a further consideration with respect to enrollment differences and that concerns the pupil's general academic motivation and objectives as well as his initial (pre ninth grade) attitudes toward mathematics and science. However, none of these factors, which may also have varied between the E and C class pupils and contributed to enrollment differences were assessed in this study, consequently it is difficult to conclude that the experimental programs as such were having any definite effect on pupil attitudes as manifested by subsequent enrollment decisions. The differences observed for the Ball State and UICSM pupils were however of sufficient magnitude to justify further study considering pupil attitudes as well as other factors.

2. Study II

Data gathered in connection with the previous study examining the possible effects of the ninth grade program of instruction on the pupil's subsequent enrollment in advanced mathematics did not include indices of the pupils'attitude toward mathematics. In that study there was the possibility that enrollment differences observed between pupils instructed with certain experimental and conventional mathematics programs may have resulted from or have been affected by initial (pre-ninth grade) differences in attitudes toward or interests in mathematics that existed independent of the program of instruction. To replicate the previous study and to do so considering pupils' existing attitudes or interests with respect to mathematics, data concerning tenth grade mathematics enrollment was gathered for an additional sample of pupils for whom scores on measures of interest in mathematics had been obtained.

Comparisons similar to those in the first study concerning enrollment in tenth grade science were not carried out in the second study. The reason was that such a high proportion of pupils enrolled in tenth grade science that it was not likely that a differential enrollment could be detected.

a. Method

This study was carried out using the second year (1965-66) sample of ninth grade pupils in classes for whom indices of mathematics attitudes and interests had been obtained via questionnaire. The sample was comprised of seventeen pairs of classes, each pair being instructed by the same teacher one class with one of the three experimental programs, the other with a conventional program. Four of the E classes had been instructed with the Ball State program, six with the UICSM program and seven with the SMSG program.

Information was obtained from the schools concerning the subjects in which these pupils enrolled in the tenth grade and their previous years' (ninth grade) grades in mathematics. Pupils were considered to have enrolled in advanced mathematics if they were taking geometry or advanced or higher algebra in the tenth grade but not if they were taking general or commercial mathematics subjects.

As in the previous study pupils were classified with respect to their level of performance in ninth grade algebra on the basis of the overall or average grade they received for the entire year. Pupils who received grades of A or B were considered "high" performers, those receiving C or D were classified as "low" performers. Pupils who had failed the subject were not included in the analysis since they would not be in a position to choose to enroll in advanced mathematics.

To determine whether E - C differences in enrollment might vary between alternate levels of pupil proficiency and/or levels of pupil interest in mathematics and to control for the possible affects of these characteristics, pupils were also classified with respect to each of these factors. Scores were obtained at the beginning of the ninth grade year on the mathematics section of the STEP and on the Aiken Mathematics Interest Scale which served, respectively, as measures of initial proficiency and of interest in mathematics. (Descriptive information for each of these measures is given in section IV A1b.) Two levels were established on each of these measures differentiating those above and below the median of the distribution of scores for all pupils in the sample.

b. Results

Table 57 shows the frequency of enrollment in advanced mathematics in tenth grade for E and C class pupils within each E program comparison condition considering pupil sex and level of performance in ninth grade algebra. Either Chi-square or the Fisher exact probability test was used to determine the reliability of the E - C differences within and across each of the cross-classification categories. For none of the E - C comparisons within or across any of the categories for any of the E program conditions were there reliable ($p < .10$) differences in frequency of enrollment. For the higher ninth grade performance pupils, approximately 82 percent enrolled in tenth grade advanced mathematics subjects while for the lower performance pupils, 51 percent enrolled. As in the previous study, the high level of enrollment, generally, on the part of the higher performance pupils did not provide a very adequate basis for enrollment comparisons.

To determine the nature of the enrollment differences between E and C class pupils considering pupil proficiency and pupil interest in mathematics further comparisons were made within levels of each of these factors for the low and high performance pupils separately. For higher performance pupils, none of the comparisons revealed reliable E - C differences and in a number of the cross-classification categories, meaningful comparisons were not possible because of the low frequency of nonenrollment. Consequently, the results of the additional analyses are shown here only for the lower ninth grade performance pupils. Table 58 shows the E - C enrollment frequencies within levels of proficiency and Table 59 within levels of interest in mathematics for the lower performance pupils.

Enrollment comparisons, using either Chi-square or the Fisher exact probability test, within levels of initial proficiency in mathematics indicated no reliable E - C differences for any of the E program comparisons. Comparisons within levels of initial interest (Table 59) did, however, indicate reliable E - C enrollment differences for the UICSM program. Among the lower performance pupils, a higher frequency of enrollment occurred for the UICSM instructed pupils having lower initial interests than for similar pupils instructed with the conventional program. The difference in this regard was larger and more reliable for boys than girls. A similar difference did not occur for pupils instructed with the UICSM program having a higher level of initial interest nor did reliable enrollment differences occur within either level of pupil interest for any of the other instructional program comparisons.

TABLE 57

Enrollment in Tenth Grade Mathematics Subjects for Pupils in E and C Classes for each E Program Comparison Condition.

E Program		BALL STATE						UICSM						SMSG					
Ninth grade math performance level		Low			High			Low			High			Low			High		
Instructional Treatment		E	C	Tot.	E	C	Tot.	E	C	Tot.	E	C	Tot.	E	C	Tot.	E	C	Tot.
Males	Enrolled	18	12	30	10	17	27	18	10	28	35	25	60	25	34	59	18	28	46
	Not Enrolled	4	7	11	1	2	3	20	22	42	1	4	5	12	10	22	3	2	5
	Total	22	19	41	11	19	30	38	32	70	36	29	65	37	44	81	21	30	51
Females	Enrolled	13	10	23	18	14	32	10	6	16	17	16	33	12	12	24	35	13	48
	Not Enrolled	10	8	18	4	5	9	22	18	40	9	12	21	20	19	39	6	5	11
	Total	23	18	41	22	19	41	32	24	56	26	28	54	32	31	63	41	18	59
All Pupils	Enrolled	31	22	53	28	31	59	28	16	44	52	41	93	37	46	83	53	41	94
	Not Enrolled	14	15	29	5	7	12	42	40	82	10	16	26	32	29	61	9	7	16
	Total	45	37	82	33	38	71	70	56	126	62	57	119	69	75	144	62	48	110

TABLE 58

Frequency of Tenth Grade Mathematics Enrollment for <u>Low</u> Ninth Grade Performance E and C Class Pupils Considering <u>Levels</u> of <u>Initial</u> <u>Proficiency</u> in Mathematics

E Program		BALL STATE						UICSM						SMSG					
Pre ninth grade math proficiency level		Low			High			Low			High			Low			High		
Instructional Treatment		E	C	Tot.	E	C	Tot.	E	C	Tot.	E	C	Tot.	E	C	Tot.	E	C	Tot.
Males	Enrolled	9	5	14	9	7	16	8	6	14	10	4	14	15	21	36	10	13	23
	Not Enroll.	3	5	8	1	2	3	12	18	30	8	4	12	8	8	16	4	2	6
	Total	12	10	22	10	9	19	20	24	44	18	8	26	23	29	52	14	15	29
Females	Enrolled	10	5	15	3	5	8	9	6	15	1	0	1	9	11	20	3	1	4
	Not Enroll.	7	6	13	3	2	5	15	16	31	7	2	9	18	15	33	2	4	6
	Total	17	11	28	6	7	13	24	22	46	8	2	10	27	26	53	5	5	10
All Pupils	Enrolled	19	10	29	12	12	24	17	12	29	11	4	15	24	32	56	13	14	27
	Not Enroll.	10	11	21	4	4	8	27	34	61	15	6	21	26	23	49	6	6	12
	Total	29	21	50	16	16	32	44	46	90	26	10	36	50	55	105	19	20	39

TABLE 59

Frequency of Tenth Grade Mathematics Enrollment for Low Ninth Grade Performance E and C Class Pupils Considering Levels of Initial Interest in Mathematics

E Program		BALL STATE						UICSM						SMSG					
Pre ninth grade math interest level		Low			High			Low			High			Low			High		
Instructional Treatment		E	C	Tot.	E	C	Tot.	E	C	Tot.	E	C	Tot.	E	C	Tot.	E	C	Tot.
Males	Enrolled	10	8	18	8	4	12	10	0	10	8	10	18	11	16	27	14	18	32
	Not Enrolled	4	3	7	0	4	4	10	16	26	10	6	16	9	9	18	3	1	4
	Total	14	11	25	8	8	16	20	16	36	18	16	34	20	25	45	9	11	20
								$p < .01$[a]											
Females	Enrolled	10	6	16	3	4	7	7	3	10	3	3	6	17	5	12	5	7	12
	Not Enrolled	8	6	14	2	2	4	13	13	26	9	5	14	15	15	30	5	4	9
	Total	18	12	30	5	6	11	20	16	36	12	8	20	22	20	42	10	11	21
All Pupils	Enrolled	20	14	34	11	8	19	17	3	20	11	13	24	18	21	39	19	25	44
	Not Enrolled	12	9	21	2	6	8	23	29	52	19	11	30	24	24	48	8	5	13
	Total	32	23	55	13	14	27	40	32	72	30	24	54	42	45	87	27	30	57
								$\chi^2=8.14$, $p < .01$											

[a] Determined by the Fisher exact probability test.

3. Discussion

In the second study differences in enrollment in tenth grade mathematics were observed only for lower ninth grade performance pupils having a lower initial interest in mathematics in the UICSM program comparison. A significantly higher proportion of UICSM instructed pupils with these characteristics enrolled in advanced mathematics than similar pupils instructed with a conventional program. In the first study there was also a higher enrollment in tenth grade mathematics for UICSM instructed pupils which occurred more generally for all lower ninth grade performance pupils. However, the higher enrollment appeared to be due in part to a larger proportion of higher proficiency pupils in the UICSM classes. In the second sample enrollment differences did not vary between the proficiency levels for the low performance pupils.

For the Ball State program, the first study indicated that lower performance boys had a higher rate of enrollment than those in conventional classes. This also appeared to be due in part to proficiency differences between E and C class pupils. Similar evidence was not obtained in the second study suggesting that the Ball State program as such was not contributing to differences in subsequent mathematics enrollment.

For the SMSG program, no enrollment differences were observed in either study.

Considering the fact that the samples of classes included in each of the two studies were instructed in different schools, by different sets of teachers, the results obtained seem to suggest that for lower ninth grade performance pupils having somewhat lower initial interests in mathematics, instruction with the UICSM program contributed to a greater likelihood of enrolling in advanced mathematics in the tenth grade. This would also seem to suggest that for these pupils the UICSM program had some positive effect on their attitudes toward mathematics.

D. Summary and Discussion of Effects Observed on Overt Behavioral Indices

Comparisons for each of the experimental programs on each of several behavioral indices of interest revealed few differences in this respect between pupils instructed with the E and C programs. In the mathematics activity bulletin study, a somewhat larger proportion of UICSM instructed girls in the ninth grade and pupils of both sexes in the tenth grade exhibited behavior indicative of a higher interest in mathematics activities than similar pupils instructed with the conventional programs. However, in a separate comparison, reliably fewer UICSM than conventional class boys in the ninth grade requested subscriptions to the Mathematics Student Journal which represented a similar index of interest in extracurricular mathematics activities.

Interest manifested by library reading of mathematics materials occurred more frequently for SMSG instructed boys and UICSM instructed girls than for comparison pupils in conventional classes. For the UICSM girls, this difference occurred more generally, i.e. over a larger sample of classes.

Comparisons made with respect to post ninth grade enrollment in advanced mathematics showed, in two separate samples, a tendency toward somewhat higher enrollment for UICSM than for conventional class pupils. A similar tendency observed in one sample for Ball State pupils did not appear in the second sample. For none of the E programs, however, were the differences on any behavior index observed consistently over all sex and/or proficiency level categories. With the exception of the difference in connection with library reading observed for the SMSG program, all of the differences were observed in the comparisons which involved the UICSM program and for all but one of the latter instances as well as that for the SMSG program, behavior representing a higher level of interest was exhibited by pupils instructed with the E rather than the C programs. It should be noted that the one difference favoring the conventional program was observed on an index that required the least amount of actual participation or involvement, the request for a subscription to the mathematics journal.

In connection with the differences that were observed, the lack of consistency in the differential effects obtained for the separate levels of proficiency and/or sexes precludes drawing any general conclusions with respect to these possible moderating factors other than those suggested above in the discussion of the separate studies.

Overall, these results do not provide a basis for concluding with any confidence that any of the experimental programs had a general differential effect of a practical magnitude on the mathematics interests underlying the behaviors observed in these studies. It should be noted that it is likely that the behaviors being reflected in each of these indices were subject to the effects and influence of factors other than the pupils interest as such even though attempts were made to minimize such effects. Because of this, these indices were probably not too highly reliable nor precise measures of interest, per se, and thereby less capable of detecting small differences that may have occurred.

Considering that the results on the separate indices were obtained from several separate samples of classes and teachers and that the indices were probably not very sensitive measures of interest, the occurrence of the several differences indicating a higher level of interest for the UICSM pupils would suggest that this program could have made some modest contribution to pupils' attitudes toward mathematics. The evidence does not support a similar statement for the Ball State or SMSG programs although the evidence also did not suggest that the latter programs were contributing to a less positive interest in mathematics.

VI. CONCLUSIONS

With respect to the question of main concern for this project, the evidence did not support an unequivocal conclusion that any of the experimental programs in secondary mathematics had a differential effect of a significant magnitude on pupils' attitudes toward or and interests in mathematics. For none of the experimental programs were differences resulting from comparisons with conventional programs observed with a high degree of consistency over the various attitude indices and/or the separate samples of pupils utilized in the project. Nonetheless the differences that were observed for two of the experimental programs were of sufficient consistency to suggest that each of these programs could have a real but very modest effect on some aspects of pupil attitudes toward mathematics.

Results obtained from the self-report indices indicated that pupils instructed with the Ball State program tended to develop less positive attitudes or interests toward mathematics than those instructed with conventional programs. For the UICSM program there were indications, mainly from the behavioral indices that this program may have contributed to the development of more positive attitudes or interests than the comparison conventional program. For pupils instructed with the SMSG program, the differences were too limited to conclude other than that this program had no discernible differential effect on pupil attitudes.

Overall, however, the differences that did occur for the Ball State and the UICSM programs did not appear to be of sufficient magnitude or generality to conclude that these programs could contribute more than the conventional programs to any strong or long range shifts in pupil attitudes or interests which might not be fairly readily modified by subsequent factors or conditions.

The clearest difference observed for any of the program comparisons concerned pupil reaction to one of the qualities of the instructional materials, the difficulty they experienced using and understanding their textbooks. Pupils instructed with the Ball State program consistently reported greater difficulty using and understanding their textbooks than did comparison pupils instructed with conventional materials. A similar difference occurred for those instructed with the SMSG program but the large amount of variation between teachers with respect to this difference precluded any generalization beyond the sample. A similar difference did not occur for pupils using the UICSM materials. The observation of program differences with respect to this quality of the instructional materials as such did indicate that pupils were sensitive to at least some characteristics that differed among the programs being compared and that this effect might be expected generally for pupils instructed with the Ball State program. Further, the fact that this quality could account for specific interest differences observed for the Ball State program, identifying thereby the source of this effect, as well as for a significant proportion of interest change for pupils' in general suggests that characteristics of instructional materials, as such, can influence affective reactions to the content of a subject matter area such as mathematics.

An examination of certain teacher connected characteristics such as their evaluation of and experience with the experimental program being taught and pupil characteristics such as sex and mathematics proficiency level did not provide any consistent evidence that these factors affected or modified the instructional program differences observed generally. Also, it did not appear that the lack of larger instructional program differences resulted from a limited amount of attitude change in general since it was estimated that for the self-report indices, a reasonably large amount of attitude change had occurred over the period of instruction.

A more general but limited assessment of the independent attitudinal affects of textbook difficulty as an instructional program characteristic and change in grades pupils' received from the previous year as a separate variable in the instructional situation showed that these factors generally had a greater effect on attitude change than any of the instructional program variations that were examined. The latter assessment also provided some expirical evidence that intrinsic interest and perceived knowledge or proficiency are somewhat independent dimensions of a general attitude toward mathematics in that changes on these dimensions were differentially related to variations in text difficulty and pupil grades.

Taken altogether the evidence suggests that very little attitude change could be attributed to the instructional program variations examined in this project. The differential effects that were observed with respect to affective outcomes would not seem to have sufficient magnitude or generality to be the basis for decisions concerning the use of those programs in an instructional situation especially when qualities and characteristics relevant to other instructional outcomes were to be considered.

On a broader scale, the results of this project suggest the need to determine more exactly the specific qualities and characteristics of instructional materials and the factors and conditions connected with their use as well as those in the total instructional situation that in general effect a change in pupils' attitudes and interests with respect to the content of a given subject matter area.

REFERENCES

1. Aiken, L.R. "Personality Correlates of Attitude Toward Mathematics," Journal of Educational Research. LVI, 1963. p. 476-480.

2. Alpert, R., Stellwagon, G., and Becker, D., "Psychological Factors in Mathematics Education." Report summary in Newsletter No. 15, School Mathematics Study Group, Stanford University, April, 1963.

3. Atkinson, J.W. An Introduction to Motivation. Princeton, New Jersey: D. VanNosfrand and Co., 1964.

4. Bereiter, C. "Some Persisting Dilemmas in the Measurement of Change," in Harris, C.W. Problems in the Measurement of Change. Madison: University of Wisconsin Press. 1963. p. 3-20.

5. Brookover, W. B., Thomas, S. and Patterson, Ann. "Self Concept of Ability and School Achievement," Sociology of Education. XXXVII, 1964. p. 271-279.

6. Castellan, N. J. Jr. "On Partitioning of Contingency Tables," Psychological Bulletin. LXII, 1965. p. 330-338.

7. Cronbach, L. J., Rajaratnam, Nageswari, and Glaser, Goldine C. "Theory of Generalizability: A Liberalization of Reliability Theory," British Journal of Statistical Psychology. XVI, part 2, 1963. p.137-163.

8. Dutton, W. H. "Attitudes of Junior High School Pupils Toward Arithmatic," School Review. LXIV, 1956. p. 18-22.

9. Fehr, H. F., "The Teaching of Mathematics in Elementary School," in Analysis of Concept Learning, edited by H. J. Klausmeier and C. W. Harris, New York, Academic Press, 1966.

10. Krathwohl, D. R., Bloom, B. S. and Masia, B. B., Taxonomy of Educational Objectives Handbook II: Affective Domain, New York, David McKay, 1964.

11. Rorer, L. G. "The Great Response - Style Myth," Psychological Bulletin. LXIII, 1965. p. 129-156.

12. Rosenberg, M. L. "A Structural Theory of Attitude Dynamics," Public Opinion Quarterly. XXIV, 1960. p. 319-340.

13. Ryan, J. J., and Rising, G. R. Participant Teacher Judgments of Experimental Programs in Secondary Mathematics. Unpublished technical report (66-3), Minnesota National Laboratory, Minnesota State Department of Education. 1966.

14. Sequential Tests of Educational Progress, Cooperative Test Division, Educational Testing Service, Princeton, New Jersey. 1957.

15. Winer, B. J. Statistical Principles in Experimental Design. New York: McGraw-Hill. 1962.

16. Wootan, W. SMSG The Making of a Curriculum. New Haven, Yale University Press, 1965.

APPENDIX

Table of Contents

F. Mathematics Activity Bulletin Request Frequencies.

Table a. Number of pupils at each total request level for each grade.

Table b. Total number and percent of pupils making requests for each successive issue of the bulletin by grade.

G. Library Reading in Mathematics - Questionnaire Form.

H. Copy of One Issue of the Mathematics Activity Bulletin.

APPENDIX A

Questionnaire Indices of Pupil Mathematics Attitudes and Interests

1. Indices of specific attitude and interest dimensions from second year study post questionnaire.

a. Instructions for responding to items.

This questionnaire is to find out what pupils think or how they feel about the different subjects that they take in school.

First you are to put an 'X' beside each of the subjects you are now taking among those in the list on the right.

___English or Literature
___Social Studies (History, Civics, etc.)
___Science (General Science, Natural Science, etc.)
___Mathematics (Algebra, General Math, etc.)
___Foreign Languages (Latin, Spanish, etc.)

You are to answer the questions in this part of the booklet for <u>each</u> of the <u>subjects</u> you <u>checked</u> above. Beneath each question there will be a scale on which you are to indicate your answers. You are to indicate your answers for <u>each</u> <u>separate</u> <u>subject</u> by drawing a short line across the scale at the place that shows how you want to answer the question for that subject. You then write the code letter for the subject above the line you have drawn. The code is given below.

LETTER CODE TO BE USED: English or Literature---E Social Studies---SS Science---SC Mathematics---M Foreign Languages---FL

<u>FOR</u> <u>EXAMPLE</u>, suppose you were asked

How far from the front of the room do you like to sit in each of your classes?

Very far from the front	Far from the front	Near the middle	Close to the front	Very close to the front

If you like to sit near the front in your English class, but near the back in your other classes, you might indicate your answers like this:

SS SC M FL E

Very far from the front	Far from the front	Near the middle	Close to the front	Very close to the front

However, if you preferred to sit near the back in all of your classes, you might answer like this:

E SS FL SC M

Very far from the front	Far from the front	Near the middle	Close to the front	Very close to the front

Or your seating preference might be quite different for each subject, and you may answer like this:

Very far from the front	Far from the front	Near the middle	Close to the front	Very close to the front

Remember:

1. Be sure to answer each question as you come to it. Do not skip any questions.

2. You are to answer for each subject that you are taking -- the subjects you checked with an X above and only those subjects, unless the question says to do otherwise.

3. Be sure to read each question carefully, each question is different.

4. You should answer each question by drawing a separate line for each subject, on the scale below the question as shown in the example.

5. Put each line at a different place on the scale -- you can put two marks right next to each other but not one on top of another.

6. Be sure to always label each line with the code letter for the subject it stands for.

7. You are to answer each question according to your own present judgement or feeling about each of these school subjects.

1. Indices of specific attitude and interest dimensions from second year study post questionnaire.

b. Content of indices.

i. <u>Intrinsic Interest Index</u>.

How much do you like or dislike each of the subjects you are now taking?

Like very much	Like some	Like a little	Do not like

How interested are you in the material and the topics included in each of the subjects you are <u>now</u> taking?

Not at all interested	Somewhat interested	Quite interested	Very much interested

If the time were made available, how would you feel about joining a school club next year having activities built around each of these subjects?

Quite interested	Somewhat interested	Slightly interested	Not at all interested

How interested are you in the material and the topics included in each of your subjects <u>compared to most other 9th grade pupils in your school</u>?

Much more interested than most	More interested than most	Less interested than most	Much less interested than most

During your leisure time this summer how much would you like or dislike reading outside materials, such as books and magazines, about topics in each of the subjects you are now taking?

Like very much	Like some	Dislike some	Dislike very much

How much interest in the topics and materials included in each subject do you have compared to your close friends?

The most interest	Somewhat more	Somewhat less	The least interest

How much do you like or dislike doing an hours homework in each of the subjects you are now taking?

Dislike very much	Dislike a little	Like a little	Like a lot

When you finish your education, how much would you like your job to include activities, topics and materials like those in each of your subjects?

Not at all	Somewhat	Quite a bit	Very much

ii. Perceived Utility Index.

How important do you feel each of your subjects is for what you want to do as an adult?

Not very important	Somewhat important	Quite important	Very important

How much would learning the material in each of your subjects help with the work or education you plan to carry out after you complete high school?

A very great help	Help quite a lot	Help some	Help a little

iii. Perceived Knowledge Index.

Considering all you have learned over the years you have been in school, how much knowledge or ability do you feel you now have in each of the subjects you are taking?

Very much knowledge	Quite a bit of knowledge	Some knowledge	Very little knowledge

Grades do not always show how much a person knows. No matter what your grades have been, how much do you believe you really know about each of these subjects compared to most other 9th grade students in your school: Mathematics (M), English (E), Social Studies (SS), and Science (SC)? Answer this question for these subjects whether you are now taking them or not.

Have much less knowledge than most	Have less knowledge than most	More knowledge than most	Have much more knowledge than most

How much have you been able to learn in each of the subjects this year compared to most other 9th grade students in your school?

Much less	Somewhat less	Somewhat more	Much more

How much knowledge and ability do you have in each of your subjects compared with your close friends?

Have the least	Less than most	More than most	Have the most

How does your present knowledge and ability in each subject you are taking compare to that of most other 9th grade students in your school?

Much less knowledge than most	Less knowledge than most	More knowledge than most	Much more knowledge than most

After you go through high school, where do you think you will stand in your high school graduating class in each of these subjects: Mathematics (M), English (E), Social Studies (SS), and Science (SC)?

Among the poorest	Below average	Above average	Among the best

Suppose all the students in the 9th grade in your school were divided into groups according to the amount of knowledge and understanding they had about a given school subject. Suppose there were 10 equal sized groups with group number _1_ being those students with the _least knowledge_, group number _10_ the students with the _most knowledge_ and groups _5_ and _6_ those near the middle. Group 6 would be for students with somewhat more knowledge than those in group 5.

Considering your own knowledge and understanding in each subject compared to that of all other students in your grade, indicate by drawing a line across the scale in which group you believe you belong for each subject. Be sure to write the code letter for each subject above the line you draw.

1	2	3	4	5	6	7	8	9	10
Least amount of knowledge									Most amount of knowledge

iv. Ease of Learning Index.

How hard would you have had to work or did you have to work to obtain an A or B average grade this year in each of the subjects you are _now_ taking?

Very hard	Quite hard	Not too hard	Not hard at all

How difficult or easy has it been for you to learn the material that is covered in each of these subjects?

Very difficult	Somewhat difficult	Quite easy	Very easy

How difficult or easy has it been for you to learn the material in each of your subjects _compared to other students in your grade_?

Much more difficult	More difficult	Somewhat easier	Very much easier

Questionnaire Indices of Pupil Mathematics Attitudes and Interests

2. Indices of general mathematics attitudes and interests.

a. <u>Aiken Mathematics Interest Scale</u>.

Below are a number of statements pupils have made about mathematics. You are to indicate <u>how much YOU agree or disagree with</u> each of <u>these statements</u> by encircling the letter representing <u>one</u> of the following expressions:

Strongly Disagree (SD) Disagree (D) Neither Agree nor Disagree (N) Agree (A) Strongly Agree (SA)

1.	I am always under a terrible strain in a math class.	SD	D	N	A	SA
2.	I do not like mathematics, and it scares me to have to take it.	SD	D	N	A	SA
3.	Mathematics is very interesting to me, and I enjoy math courses.	SD	D	N	A	SA
4.	Mathematics is fascinating and fun.	SD	D	N	A	SA
5.	Mathematics makes me feel secure, and at the same time it is stimulating.	SD	D	N	A	SA
6.	My mind goes blank, and I am unable to think clearly when working math.	SD	D	N	A	SA
7.	I feel a sense of insecurity when attempting mathematics.	SD	D	N	A	SA
8.	Mathematics makes me feel uncomfortable, restless, irritable and impatient.	SD	D	N	A	SA
9.	The feeling that I have toward mathematics is a good feeling.	SD	D	N	A	SA
10.	Mathematics makes me feel as though I'm lost in a jungle of numbers and can't find my way out.	SD	D	N	A	SA
11.	Mathematics is something which I enjoy a great deal.	SD	D	N	A	SA
12.	When I hear the word math, I have a feeling of dislike.	SD	D	N	A	SA
13.	I approach math with a feeling of hesitation, resulting from a fear of not being able to do math.	SD	D	N	A	SA
14.	I really like mathematics.	SD	D	N	A	SA
15.	Mathematics is a course in school which I have always enjoyed studying.	SD	D	N	A	SA
16.	It makes me nervous to even think about having to do a math problem.	SD	D	N	A	SA
17.	I have never liked math, and it is my most dreaded subject.	SD	D	N	A	SA
18.	I am happier in a math class than in any other class.	SD	D	N	A	SA
19.	I feel at ease in mathematics, and I like it very much.	SD	D	N	A	SA
20.	I feel a definite positive reaction to mathematics; it is enjoyable.	SD	D	N	A	SA

2. Indices of general mathematics attitudes and interests.

b. Dutton Mathematics Attitude Scale.

Below are some statements about mathematics as a school subject. Read all of these statements and then choose those statements that best tell how you feel about mathematics. Put a check (√) in the space before ONLY those statements that best represent your present judgement or feelings--probably not more than five statements.

____1. I think about mathematics problems outside of school and like to work them out.

____2. I don't feel sure of myself in mathematics.

____3. I enjoy seeing how rapidly and accurately I can work mathematics problems.

____4. I like mathematics, but I like other subjects just as well.

____5. I like mathematics because it is practical.

____6. I don't think mathematics is fun, but I always want to do well in it.

____7. I am not enthusiastic about mathematics, but I have no real dislike for it either.

____8. Mathematics is as important as any other subject.

____9. Mathematics is something you have to do even though it is not enjoyable.

____10. Sometimes I enjoy the challenge presented by a mathematics problem.

____11. I have always been afraid of mathematics.

____12. I would like to spend more time in school working mathematics.

____13. I detest mathematics and avoid using it at all times.

____14. I avoid mathematics because I am not very good with figures.

____15. Mathematics thrills me, and I like it better than any other subject.

____16. I never get tired of working with numbers.

____17. I am afraid of doing word problems.

____18. Mathematics is very interesting.

____19. I have never liked mathematics.

____20. I think mathematics is the most enjoyable subject I have ever taken.

____21. I can't see much value in mathematics.

APPENDIX B

First Year Questionnaire Study Analysis Designs.

1. Four Factor Partially Hierarchal Analysis of Variance Design

a. Layout of Analysis of Variance Design

	Treatment Premeasure	B_1 (E) C_1(low)	C_2(high)	$C.$	B_2 (C) C_1	C_2	$C.$	$B.$ C_1	C_2	$C.$
Program	Teacher									
A_1	$D_{1(1)}$	X_{1111}	X_{1121}	$X_{11.1}$			$X_{12.1}$	$X_{1.11}$	$X_{1.21}$	$X_{1..1}$
(Ball State)	$D_{2(1)}$	X_{1112}								
	.									
	.									
	$D_{L(1)}$									
	$D_{\cdot(1)}$	$X_{111.}$	$X_{112.}$	$X_{11..}$			$X_{12..}$	$X_{1.1.}$	$X_{1.2.}$	$X_{1...}$
A_2	$D_{1(2)}$									
(UICSM)	.									
	.									
	$D_{L(2)}$									
	$D_{\cdot(2)}$	$X_{211.}$	$X_{212.}$	$X_{21..}$			$X_{22..}$	$X_{2.1.}$	$X_{2.2.}$	$X_{2...}$
A_3	$D_{1(3)}$									
(SMSG)	.									
	.									
	$D_{L(3)}$									
	$D_{\cdot(3)}$	$X_{311.}$	$X_{312.}$	$X_{31..}$			$X_{32..}$			$X_{3...}$
$A.$		$X_{.11.}$	$X_{.12.}$	$X_{.1..}$			$X_{.2..}$			$X_{....}$

b. Elements and Notation for the Four Factor Design.

	Factor	Notation and levels	Distribution of factor levels	Sampling correction factor
A:	Program	$i = 1, \ldots I$, where $I = 3$	fixed $I=I'$	$1-\frac{I}{I'} = 0$
B:	Treatment	$j = 1, \ldots J$, where $J = 2$	fixed $J=J'$	$1-\frac{J}{J'} = 0$
C:	Premeasure	$k = 1, \ldots K$, where $K = 2$	fixed $K=K'$	$1-\frac{K}{K'} = 0$
D:	Teacher	$l = 1, \ldots L$, where L = Number of teachers	random $L << L'$	$1-\frac{L}{L'} = 1$
		$m = 1, \ldots M$, where M = Number of pupils/cell (unequal in each cell)	random $M << M'$	$1-\frac{M}{M'} = 1$

Factor D (teacher) is nested under factor A (curriculum).

The model for this analysis has the form:

$$X_{ijklm} = \mu + \alpha_i + \beta_j + \gamma_k + \alpha\beta_{ij} + \alpha\gamma_{ik} + \beta\gamma_{jk} + \alpha\beta\gamma_{ijk} + \delta_{l(i)} + \beta\delta_{jl(i)}$$

$$+ \gamma\delta_{kl(i)} + \beta\gamma\delta_{jkl(i)} + \varepsilon_{m(ijkl)} .$$

c. Degrees of Freedom, Expected Mean Squares and Appropriate Error Terms for Four Factor Design.

Source of variation	Degrees of freedom	Expected mean square	Appropriate error term
A	I-1	$\sigma^2_\varepsilon + JKM\sigma^2_{D(A)} + JKLM\sigma^2_A$	$MS_{D(A)}$ or $MS_{S(ABCD)}$
B	J-1	$\sigma^2_\varepsilon + KM\sigma^2_{B\cdot D(A)} + IKLM\sigma^2_B$	$MS_{B\cdot D(A)}$ or $MS_{S(ABCD)}$
C	K-1	$\sigma^2_\varepsilon + JM\sigma^2_{C\cdot D(A)} + IJLM\sigma^2_C$	$MS_{C\cdot D(A)}$ or $MS_{S(ABCD)}$
AB	(I-1) (J-1)	$\sigma^2_\varepsilon + KM\sigma^2_{B\cdot D(A)} + KLM\sigma^2_{AB}$	$MS_{B\cdot D(A)}$ or $MS_{S(ABCD)}$
AC	(I-1) (K-1)	$\sigma^2_\varepsilon + JM\sigma^2_{C\cdot D(A)} + JLM\sigma^2_{AC}$	$MS_{C\cdot D(A)}$ or $MS_{S(ABCD)}$
BC	(J-1) (K-1)	$\sigma^2_\varepsilon + M\sigma^2_{BC\cdot D(A)} + ILM\sigma^2_{BC}$	$MS_{BC\cdot D(A)}$ or $MS_{S(ABCD)}$
ABC	(I-1) (J-1) (K-1)	$\sigma^2_\varepsilon + M\sigma^2_{BC\cdot D(A)} + LM\sigma^2_{ABC}$	$MS_{BC\cdot D(A)}$ or $MS_{S(ABCD)}$
D(A)	I(L-1)	$\sigma^2_\varepsilon + JKM\sigma^2_{D(A)}$	$MS_{S(ABCD)}$
C•D(A)	(K-1)I(L-1)	$\sigma^2_\varepsilon + JM\sigma^2_{C\cdot D(A)}$	$MS_{S(ABCD)}$
B•D(A)	(J-1)I(L-1)	$\sigma^2_\varepsilon + KM\sigma^2_{B\cdot D(A)}$	$MS_{S(ABCD)}$
BC•D(A)	(J-1)(K-1)I(L-1)	$\sigma^2_\varepsilon + M\sigma^2_{BC\cdot D(A)}$	$MS_{S(ABCD)}$
S(ABCD)	$N_{....} - IJKL$	σ^2_ε	
	$N_{....} - 1$		

In testing the effects of the nested dimension, D(A), C•D(A), B•D(A) and BC•D(A), preliminary tests are required. By using the adjusted within cells error as denominator in the F ratio, these tests were run at $\alpha = .25$. If all these tests were null (i.e. $\delta i(i)$, $\beta\delta_j e(i)$, $\gamma\delta_{ke}(i)$, and $\beta\gamma\delta_j ke(i)$ were dropped from the model) then the adjusted within cells error was used to test the remaining interactions and main effects. If all the preliminary tests were significant, then the corresponding error term shown in the table was used to test the main effects and remaining interactions.

Because the variance estimates for D(A), C•D(A), B•D(A) and BCD(A) are obtained by pooling the respective variances within each nested level (i.e. E program comparison condition), the model assumes that these variances are homogeneous. A homogeneity of variance test (F_{max} Winer (15), pp. 92-96) was used to test this assumption for each of the variance sources. Since F tests are quite robust with respect to departures from homogenity of variance the null hypothesis was rejected only when $p \leq .01$. When the latter hypothesis was rejected, only comparisons made within rather than across the nested condition, i.e., only an analysis for each alternate E program condition, using the model given below, could indicate the actual treatment effects.

2. Three Factor Analysis of Variance Design.

The model for the within program three-factor design was:

$$X_{jklm(i)} = \mu_i + \beta_j + \gamma_k + \delta_l + \beta\gamma_{jk} + \beta\delta_{jl} + \gamma\delta_{kl} + \beta\gamma\delta_{jkl} + \varepsilon_{m(jkl)(i)}$$

The degrees of freedom, expected mean squares, and appropriate error terms are shown below:

Source of variation	Degrees of freedom	Expected mean square	Appropriate error term
B	J-1	$\sigma^2_\varepsilon + KM\sigma^2_{BD} + KLM\sigma^2_B$	MS_{BD} or $MS_{S(BCD)}$
C	K-1	$\sigma^2_\varepsilon + JM\sigma^2_{CD} + JLM\sigma^2_C$	MS_{CD} or $MS_{S(BCD)}$
BC	(J-1)(K-1)	$\sigma^2_\varepsilon + M\sigma^2_{BCD} + LM\sigma^2_{BC}$	MS_{BCD} or $MS_{S(BCD)}$
D	L-1	$\sigma^2_\varepsilon + JKM\sigma^2_D$	$MS_{S(BCD)}$
BD	(J-1)(L-1)	$\sigma^2_\varepsilon + KM\sigma^2_{BD}$	$MS_{S(BCD)}$
CD	(K-1)(L-1)	$\sigma^2_\varepsilon + JM\sigma^2_{CD}$	$MS_{S(BCD)}$
BCD	(J-1)(K-1)(L-1)	$\sigma^2_\varepsilon + M\sigma^2_{BCD}$	$MS_{S(BCD)}$
S(BCD)	$N_{\cdots} - JKL$	σ^2_ε	
TOTAL	$N_{\cdots} - 1$		

The criterion for the preliminary test on the interaction effects BD, CD, BCD was $\alpha = .25$. If the null hypothesis was rejected, then MS_{BD} was used as the error term for testing the B effect, MS_{CD} for C effect, MS_{BCD} for BC effect.

APPENDIX C

Text difficulty rank position frequencies

		Ball State						UICSM						SMSG					
		E			C			E			C			E			C		
Sex	t.d. rank \ Pre EOL Level	low	high	total	low	high	total	low	high	total	low	high	total	low	high	total	low	high	total
	1	0	10	10	5	20	25	4	15	19	5	13	18	1	6	7	5	21	26
M	2	2	12	14	8	27	35	7	11	18	6	16	22	5	9	14	14	17	31
	3	29	22	51	24	18	42	19	20	39	18	15	33	27	41	68	21	20	41
		31	44	75	37	65	102	30	46	76	29	44	73	33	56	89	40	58	98
	1	4	5	9	5	12	17	0	7	7	6	6	12	2	5	7	10	17	27
F	2	16	8	24	16	18	34	7	9	16	12	12	24	6	8	14	14	17	31
	3	49	24	73	21	9	30	30	11	41	33	8	41	62	23	85	26	9	35
		69	37	106	42	39	81	37	27	64	51	26	77	70	36	106	50	43	93
	1	4	15	19	10	32	42	4	22	26	11	19	30	3	11	14	15	38	53
All Pupils	2	18	20	38	24	45	69	14	20	34	18	28	46	11	17	28	28	34	62
	3	78	46	124	45	27	72	49	31	80	51	23	74	89	64	153	47	29	76
		100	81	181	79	104	183	67	73	140	80	70	150	103	92	195	90	101	191

APPENDIX D

Second Year Questionnaire Study:

Three Factorial Analysis of Covariance Design

The basic observation of the post measure of the attitude index was considered to be Y_{ijkl} where:

l = the lth subject and $l = 1, 2, \ldots, L'$

k = the kth sex and $k = 1,2$

j = the jth treatment level and $j = 1,2$

i = the ith teacher and $i = 1,2, \ldots, I'$

The basic observation on itital attitude was defined as X_{ijkl} and for grade change as Z_{ijkl} with the subscripts i, j, k, l being defined as they were for the Y score. Where $N_{ijk} = N_{i'j'k'} = L'$ for all i, j, and k. The structural model was:

$$Y_{ijkl} = \mu + \alpha_i + \gamma_j + W_k + \alpha\gamma_{ij} + \alpha W_{ik} + \gamma W_{jk} + \alpha\gamma W_{ijk}$$
$$+ \beta_{y\cdot x}(X_{ijkl} - \overline{X}\ldots) + \beta_{y\cdot z}(Z_{ijkl} - \overline{Z}\ldots) + \varepsilon_{ijkl}$$

where

μ = grand mean

α_i = ith teacher effect

γ_i = jth treatment effect

W_k = kth sex effect

$\alpha\gamma_{ij}$ = ijth teacher by treatment effect

αW_{ik} = ikth teacher by sex effect

γW_{jk} = jkth treatment by sex effect

$\alpha\gamma W_{ijk}$ = ijkth teacher by treatment by sex effect

$\beta_{y \cdot x}$ = within cell partial population linear-regression coefficient for post attitude given pre attitude

$\beta_{y \cdot z}$ = within cell partial population linear-regression coefficient for post attitude given grade change

ε_{ijkl} = residual

This structural model assumes that all effects are fixed constants which is the case where all subjects and all teachers of interest (i.e. all those to whom the results are to be generalized) are included in the design. In the sampling model, two variables, I' and L', were sampled and the following definitions with respect to the sampling model were assumed.

(1) $I << I'$ $\quad 1 - I/I' \to 1$

(2) $J = J' = 2$ $\quad 1 - J/J' = 0$

(3) $K = K' = 2$ $\quad 1 - K/K' = 0$

(4) $L << L'$ $\quad 1 - L/L' \to 1$

(5) α_i NID $(0, 6^2\alpha_i)$

(6) $\alpha\gamma_{ij}$ NID $(0, 6^2\alpha\gamma_{ij})$

(7) αW_{ik} NID $(0, 6^2\alpha W_{ik})$

(8) $\alpha\gamma W_{ijk}$ NID $(0, 6^2\alpha\gamma W_{ijk})$

(9) ε_{ijkl} NID $(6^2\varepsilon)$

The model and the definitions imply that

1) I teachers were randomly sampled from a population of I' teachers.

2) IJL students were randomly sampled from k different populations (M & F) of size L'.

3) Each ijk cell has L students.

The actual sample did not meet the condition that the cell n's were equal, i.e.

$$L \neq \frac{n_{ijk}}{N_{\cdot\cdot\cdot}} \neq \frac{n_{i'j'k'}}{N_{\cdot\cdot\cdot}}$$

where

$n_{i\cdot\cdot} \neq n_{i\cdot\cdot}$ and/or

$n_{\cdot j\cdot} \neq n_{\cdot j'}$ and/or

$n_{\cdot\cdot k} = n_{\cdot\cdot k'}$

It was assumed that the differential n's were unrelated to the treatment dimensions and that, therefore, an unweighted means analysis of covariance would yield the best unbiased linear estimate of the parameters in the population model. It was also assumed that the contrasts given were appropriate approximations to the estimates which would have been obtained under the ideal sampling conditions which were defined above.

The analysis of covariance model required the following assumptions as given by Winer (15, p. 618).

1) The treatment and regression effects were additive. This implies that the regressions were homogeneous which was explicitly tested.

2) The residuals were normally and independently distributed with zero means and the equal variance. This implies that the proper form of regression equation (linear in this model) was fitted.

3) The assumptions underlying the usual analysis of variance approach were appropriate.

The expected mean squares and appropriate error terms after covariate adjustments are the same as those given for the three factor analysis of variance design shown in Appendix C. The degrees of freedom are also the same with the exception of the degrees of freedom for the within cell effect. The adjustment for the last effect is N... - JKL - number of covariates in the model.

APPENDIX E

Questionnaire Study - Second Year:

Summary of Results of Test of Within-cell Homogeneity of Regression Coefficients for each Index and E Program Comparison Condition Considering Two Covariates.

	Ball State			UICSM			SMSG		
Source of variance	df	MS	F	df	MS	F	df	MS	F
Aiken Scale									
Regression	37	19.0	<1.0	44	37.2	1.4*	38	31.0	1.3
Error	117	26.9		141	27.		140	24.7	
Intrinsic Interest									
Regression	37	40.6	<1.0	43	65.7	1.2	38	68.9	1.5*
Error	118	45.7		161	55.0		141	47.3	
Perceived Utility									
Regression	37	67.4	1.1	43	87.3	1.2	38	134.0	2.2*
Error	119	60.8		163	71.5		141	60.8	
Perceived Knowledge									
Regression	37	50.0	1.6*	44	50.3	<1.0	38	73.5	1.4*
Error	118	36.5		162	63.1		141	52.5	
Ease of Learning									
Regression	36	26.0	1.1	44	15.2	<1.0	38	16.5	1.1
Error	120	23.1		162	20.2		140	14.9	

*p < .10

APPENDIX F

Mathematics Activity Bulletin Request Frequencies.

Table a

Number of Pupils at Each Total Request Level for Each Grade.

Total Requests Made

Grade	0	1	2	3	4	5	6	Total
9	276	64	63	29	11	19	10	472
10	731	128	105	57	48	30	31	1130
11	669	124	100	42	28	33	16	1012

Table b

Total Number and Percent of Pupils Making Requests for Each Successive Issue of the Bulletin by Grade.

Issue Number

Grade	2	3	4	5	6	7	No requests
9	196 (42)*	132 (28)	69 (15)	40 (9)	29 (6)	10 (2)	276 (58)
10	399 (35)	271 (24)	166 (15)	109 (10)	61 (5)	31 (3)	731 (65)
11	343 (34)	219 (22)	119 (12)	77 (8)	49 (5)	16 (2)	669 (66)
Total	938 (36)	622 (24)	354 (14)	226 (9)	139 (5)	57 (3)	1676 (64)

*Percent of each grade total shown in parentheses.

APPENDIX G

Library Reading in Mathematics - Questionnaire Form

Please read the following questions and answer them carefully.

1. Have you read part of or completely any books in or about mathematics of any type during the past school year in addition to your mathematics textbook?

Yes __________ No __________

If "no", go on to question number 2.

If "yes", would you please answer the following questions then go on to question number 2.

How many books involving mathematics have you read completely? _____

How many books involving mathematics have you read partly, that is those in which you read one or more chapters or sections? _____

Please list the titles (as best you can remember) of these books whether you have read them completely or just partly. If you can't remember the title, indicate what the book was about. Put each book on a different line.

______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

Please put a star (*) beside those books you have read completely.

2. During the past year, have you ever looked in your school library for books in or about mathematics?

Yes __________ No __________

Angles on Mathematics

IDEAS GAMES STORIES PUZZLES

NO.4- Number Curiosities

Old Methods of Multiplication

The ability to multiply easily is something taught now in the lower grades of elementary school, but five or six centuries ago it was a topic studied only in the most advanced universities.

The first printed arithmetic, printed in 1478, showed several different methods of multiplying numbers together. The most popular of these is the "grating" method, shown below.

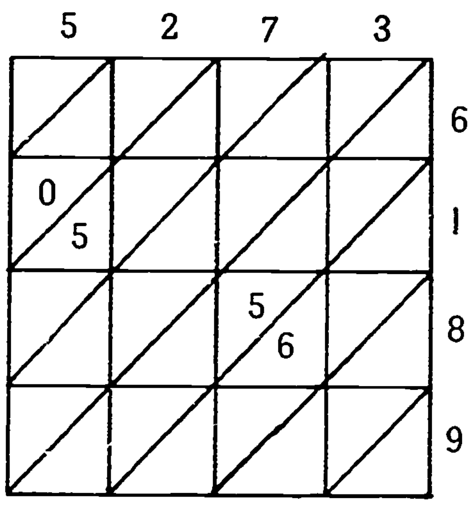


Fig. I

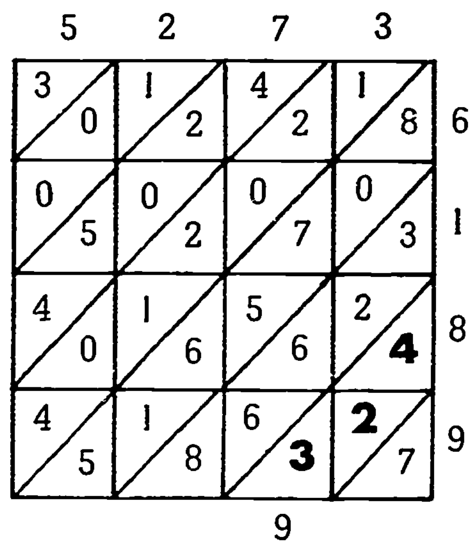


Fig. II

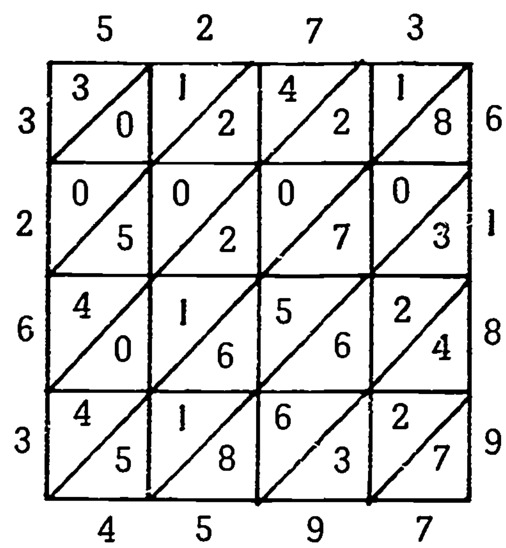


Fig. III

We will multiply 5273 by 6189. Along the top write the multiplicand; along the right side write the multiplier, one digit outside each box as in Figure I. Now write the product of each pair of digits diagonally in the appropriate box. If the product has only one digit, put a zero in front of it. Two products are entered in Figure I. When the grating is completely filled, as in Figure II, add along the diagonals. The darker numerals show how this is done. If necessary, "carry" into the next diagonal as in ordinary addition. The complete product can now be read, beginning at the top of the left hand column, and continuing along the bottom from left to right. Thus, the product of 5273 and 6189 is 32,634,597.

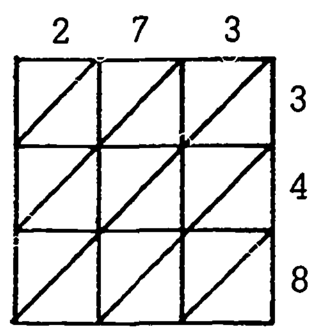


Fig. IV

Now try your hand at the problem in Figure IV, 273 x 348, and then try multiplying several additional pairs of numbers using this "grating" method. Check your work by using the ordinary method of multiplication. Is it necessary for both numbers to have the same number of digits? Which method is faster? Which do you prefer?

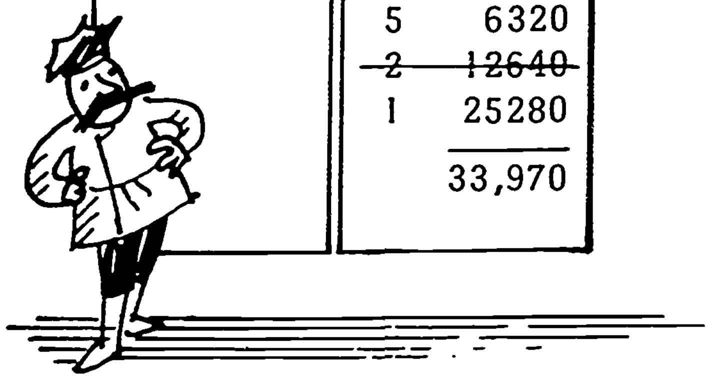
Another system of multiplication, this one in widespread use among less educated classes in China, Italy, and Russia, is multiplication by doubling, frequently called "Russian Peasant Multiplication". The advantage of this system is that one needs no knowledge of multiplication other than the two-times tables. Its disadvantage is that it is only useful for multiplication of whole numbers.

Fig. V

86 x 395

Fig. VI

~~86~~	~~395~~
43	790
21	1580
~~10~~	~~3160~~
5	6320
~~2~~	~~12640~~
1	25280
	33,970



To use this method, write in line the two numbers to be multiplied. We use the example 86 x 395. Halve the number on the left (ignoring any remainder) and double the number on the right, with the results on the next line as in Figure V. Continue doing this until the last number in the left-hand column is 1. Now look down the left-hand column; wherever there is an even number, cross out its opposite number in the right-hand column. This is done in Figure VI. Add the numbers remaining in the right-hand column to obtain the product, in this case, 33,970.

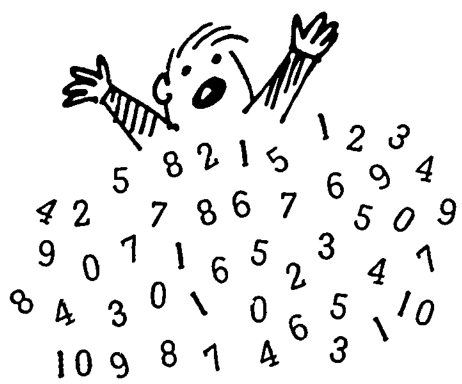
Try some products by this method. Can you see why it works? The hardest part to understand is the reason for crossing out the numbers next to even "halves" and leaving those next to odd "halves". It may help for you to write the products next to the numbers in the right column as in Figure VII.

6	x	~~7 = 7 x 1~~
3		14 = 7 x 2
1		28 = 7 x 4
		42 = 7 x 6

Fig. VII

This method is closely related to that used to multiply Roman Numerals. Try multiplying two Roman Numerals by this means. Does this work better than our regular multiplicative algorithm for multiplication of Roman Numerals?

Number Curiosities and Puzzles

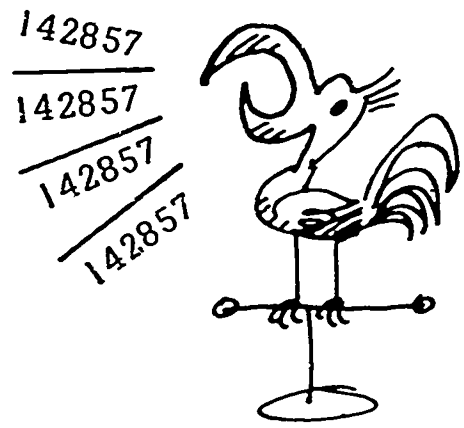


1. By multiplying 999,999 by each of the digits in sequence, we obtain products in which the first and last digits rise and fall in reverse order:

Thus, 999,999 · 2 = 1,999,998
999,999 · 3 = 2,999,997
999,999 · 4 = 2,999,996   and so on.

Without performing the multiplication, what is the product 999,999 · 8 ?

2. The fraction 1/7, when changed to a decimal, becomes .142857142857142857.... The digits 142857 keep repeating themselves no matter to how many places the division is carried out.



If we take the same digits, and multiply them by 2, 3, 4, 5, and 6, we get the following results:

$$142857 \cdot 2 = 285714$$
$$142857 \cdot 3 = 428571$$
$$142857 \cdot 4 = 571428$$
$$142857 \cdot 5 = 714285$$
$$142857 \cdot 6 = 857142$$

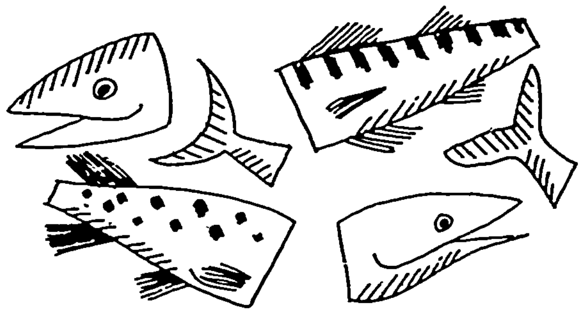
What do you think would be the result of multiplying 142857 by 7? Do you suppose you would once again get the same digits in a different order? Try the multiplication for startling results.

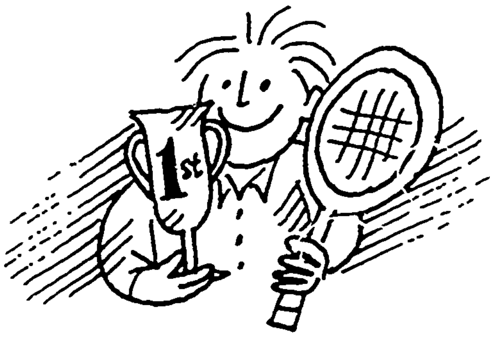
3. Now take the number 12,345,679. (Note that this number contains all the digits <u>except eight</u>, in ascending order.)

Multiply	12,345,679	by	1 x 9,	and your result is	111,111,111
"	"	"	2 x 9,	" " " "	222,222,222
"	"	"	3 x 9,	" " " "	333,333,333
"	"	"	4 x 9,	" " " "	444,444,444
"	"	"	5 x 9,	" " " "	555,555,555
"	"	"	6 x 9,	" " " "	666,666,666
"	"	"	7 x 9,	" " " "	777,777,777
"	"	"	8 x 9,	" " " "	888,888,888
"	"	"	9 x 9,	" " " "	999,999,999

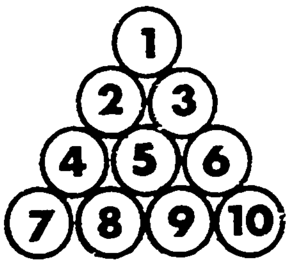
1. Two towers, one 30, the other 40 rods high, are 50 rods apart. There is a milestone on the straight line between these towers. From the tops of both towers two crows fly off simultaneously and with the same speed in a straight line in the direction of the milestone and reach their goal simultaneously. How far is the milestone from each tower?

2. Nat went fishing and caught a mackerel and a pickerel. The body of the pickerel was twice the length of his tail, and about equal to length of his head plus the tail of the mackerel. The body of the mackerel was as long as the whole pickerel minus the head. The head of the mackerel was as long as the tail of the pickerel, while the head of the pickerel was 1/4 of the length of the body of the mackerel, about 3 feet long. How big was each fish?

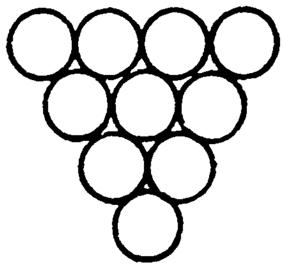




3. If 78 players enter a tournament for a singles championship, how many matches have to be played to determine the winner?



4. Rearrange these coins by moving only 3 coins to make them look like this:



5. My age is thrice my age three years hence minus thrice my age three years ago. How old am I?

ANSWERS TO ISSUE 3 PERPLEXITIES

1. 2 pennies, 3 dimes, a quarter, and a half-dollar

2. (a) Half a dozen dozen
   (b) Six dozen dozen

3. 1890π. There are 270 grooves of average length 7π.

4. 15, counting those arriving just as our train pulls out of New York and leaving as we arrive in San Francisco.

5. There is no relation between the sum of the balances and the sum of withdrawals. (Make a table for withdrawals of $10.00 per time.)

How to order the next issue of

Angles on Mathematics

IDEAS GAMES STORIES PUZZLES

Fill out the heading on the enclosed sheet and show some work on one or more of the problems in this issue. Mail in this sheet in the envelope provided to obtain the next issue. You need not solve any problem completely to get the next issue, but you must show some attempt at solving at least one problem. (This information will show us how difficult the problems are.)

OE 6000 (REV. 9-66)

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF EDUCATION

ERIC REPORT RESUME

(TOP)

ERIC ACCESSION NO.				
CLEARINGHOUSE ACCESSION NUMBER	RESUME DATE: 1 -10- 68	P.A.	T.A.	IS DOCUMENT COPYRIGHTED? YES ☐ NO ☒ — ERIC REPRODUCTION RELEASE? YES ☒ NO ☐

TITLE

Effects of Modern and Conventional Mathematics Curricula on Pupil Attitudes, Interests and Perception of Proficiency

PERSONAL AUTHOR(S)

James J. Ryan

INSTITUTION (SOURCE) Minnesota State Department of Education, St. Paul, Minnesota, Minnesota National Laboratory

SOURCE CODE

REPORT/SERIES NO.

OTHER SOURCE

SOURCE CODE

OTHER REPORT NO.

OTHER SOURCE

SOURCE CODE

OTHER REPORT NO.

PUB'L. DATE Jan. - 15 -1968 CONTRACT/GRANT NUMBER OE-5-10-051

PAGINATION, ETC. 164 Pages

RETRIEVAL TERMS

IDENTIFIERS

ABSTRACT

This project was carried out to determine the effects of three experimental "modern" programs in secondary mathematics, (Ball State, UICSM, and SMSG) on the attitudes and interests pupils develop toward mathematics and to examine factors related to these effects. The project included several separate studies involving altogether 126 pairs of mathematics classes (mostly ninth grade). Each pair, one an E the other a C class, was instructed by the same teacher. Comparisons were made in terms of self-report indices measuring general and specific attitude and interest dimensions, including the pupil's perception of his own proficiency and indices of overt behavioral manifestations of mathematics interest. Over the range of indices and samples of pupils, results indicated that the E programs had little differential effect, in comparison to C programs, on pupil attitudes and interests. However, there was a tendency, shown on the self-report indices for the Ball State program to develop less positive attitudes; and from the behavioral indices, for the UICSM program to contribute to more positive attitudes. Some of the attitude differences resulted from greater pupil difficulty with the program materials. Two factors found to independently account for a moderate proportion of attitude change <u>in general</u> were change in grade received relative to the previous year and difficulty with the instructional materials.